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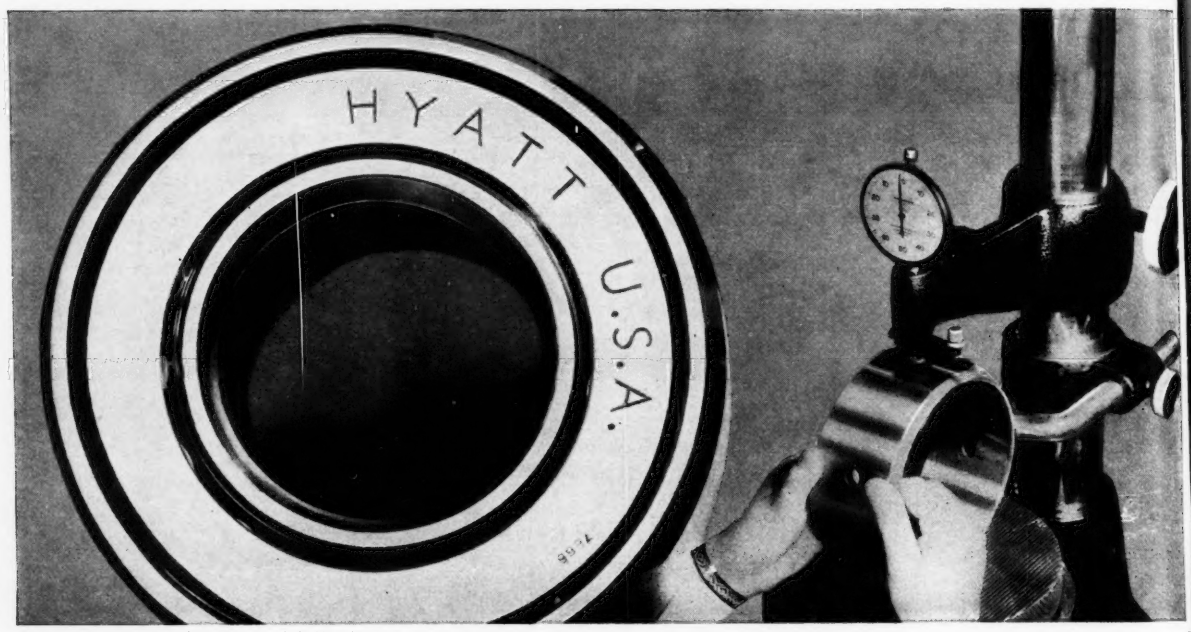


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Volume 14 AUGUST 1933 Number 8

# Recent Developments in Farm Electrification[1]

By Geo. W. Kable[2]

FARM electrification continues to be a challenging problem in the field of agricultural engineering. The farmers of the United States pay from one to two billion dollars per year for power. If they used only electric power, it would require practically all the capacity of all the existing generating plants in the country to supply them. The potential power demand is greater than for the electrification of all the steam railroads of the country. And today, after more than twenty years of availability and about eight years of solicitation on the part of the electric power companies, only 11.2 per cent of the farms are receiving central station service and are using it for less than 2 per cent of their power needs.

Farm power men—the agricultural engineers who are commonly associated with the odor of gasoline and distillate—need not fear the presumption of the possible complete electrification of the farm. Your advantage of experience in design and sales will cause you to be in the electrical procession long before the last farm is tied in to a national network and equipped with an electric tractor.

The rural electrification specialist who has packed his grip, pulled up stakes, and come to this meeting hoping for some word of a job may prefer not to be reminded too much of recent developments in farm electrification. Some of the developments of the past year would require expert statistical manipulation and the best of social psychology to be made to appear encouraging. A little digging under the surface and dusting off of possibilities, however, tends to brighten up appearances, and, if we have been severely deflated and "de-banked," they may even be cheering.

In line with the rural electrification policy of stating the facts whether favorable or otherwise, I shall parade the "otherwise" developments first in the hope that I may leave you later with a more optimistic view of the immediate future.

One of the outstanding developments of the year was the passage of the National Electric Light Association between the millstones of depression. This organization had been godfather to much of the rural electrification development. It has been replaced by the Edison Electric Institute, a new organization with a somewhat different program and a considerably flattened purse. As a result of the grinding process, the geographical divisions of the former N.E.L.A. have lost a parent and the rural service committees have been disbanded. Rural lines activities have survived in the new Institute as a subcommittee on "rural sales" of the general sales committee. The Committee on the Relation of Electricity to Agriculture will continue its work, but on a reduced scale. The electric utility association has had no monopoly on reduced budgets or flat purses. Many of the men who have been engaged in research or educational work for colleges or utilities have found it necessary to reduce their activities, or have been detailed to more immediately productive efforts in the sales field. Utilities have in many cases ceased rural line construction either from lack of ability of farmers or the utilities themselves to finance the work.

These constitute the distressing developments in rural electrification.

The conditions which all of us, from Republicans to engineers, know so well have not affected rural electrification as badly as might be expected. As late as the year 1932 there was an increase of over 6000 in the number of farms receiving electric service. Each year some farmers have found some means for having lines extended to them. If we draw a graph of the yearly increase in farms served, we have the outline of a Bactrian camel. The tail of this camel is in the year 1924 and his back rises rapidly to the first hump in 1928. This hump represents 113,000 additional farms served that year. The second hump, 73,000 farms high, gets its shape in 1930. Just now we are in the depressed curve of the camel's neck and will have to wait for 1933-34 statistics to find out whether the camel has his head up and is again starting across the great rural electrification desert, or whether he is a repealist and stopping for a drink.

While not believing too much in a happiness founded upon statistical manipulation, there are a few facts which can be extracted from figures, that are encouraging.

The 1930 Census tells us that 570,953 farms reported paying $46,480,436 to power companies for electric service in 1929. This is $81.40 per year per farm. Perhaps that

[1]Paper presented at a general session of the 27th annual meeting of the A.S.A.E. held at Purdue University, June 1933.

[2]Director, National Rural Electric Project; research director, Committee on the Relation of Electricity to Agriculture.

isn't a "smell" in comparison with gasoline, but it indicates a genuine appreciation for electricity on the farm. This outlay for most farms represents an investment in comfort and conveniences. Measured in miles of smiles it would probably reach farther than most of the investments farmers have made in recent years.

Evidence of increasing use of energy is contained in reports from many sections of the country. The Public Service Company of Northern Illinois reports average annual rural consumption of 744, 768, and 852 kwh for 1929, 1930, and 1931. The Alabama Power Company has had an increase of 814 to 895 kwh from 1930 to 1931; and from Pennsylvania comes the reported increase from 520 to 840 kwh between 1927 and 1931. In the Roanoke district of the Appalachian Electric Power Company the average annual consumption per farm customer rose from 1,003 kwh in 1928 to 1,230 kwh in 1931, while the net rate dropped from 5.3 to 4.45 cents per kilowatt-hour. The average annual consumption for the whole state of Michigan increased from 360 kwh in 1926 to 750 kwh in 1931. And these are not exceptional cases of farm consumption. In the entire eastern section of the United States where irrigation is not prevalent, the consumption increased from 745 kwh in 1930 to 775 kwh in 1931; and west of Arkansas, while the consumption decreased somewhat, the average was well above 7,000 kwh per farm in both years.

One other phase of the consumption record is of interest. In the past, power companies have placed limits on line construction based on the number of prospective customers per mile. Careful cost records of at least one company have shown that, as this company reached out more aggressively to serve the less thickly settled districts, the annual kilowatt-hours sold per mile was almost inversely proportional to the number of customers per mile. With increasing use, the average rate per kilowatt-hour also became less, but even at the lesser charge the revenue per mile was forty dollars greater with five customers per mile than it was with nine. This is not a brief for sparsely settled regions, but it is an indication that profit is available in the wider spaces if sought for and accompanied by aggressive action.

The past year has seen a considerable development in electric soil heating. Many plant growers have decided to buy their soil heaters by the linear foot instead of by the cubic yard or ton weight. Five manufacturers disposed of 330,000 ft of soil heating cable between May 1, 1932 and May 1, 1933. This is sufficient cable for 5,500 six-by-six-foot hotbeds. Approximately 2,000 thermostats were sold to control the heating of these beds. This is a beginning of what promises to be a very popular use for electricity by urban gardeners as well as by commercial and farm growers of plants.

## MANY INTERESTING NEW DEVELOPMENTS IN FARM ELECTRIFICATION

Three manufacturers are now offering a new type of controlled steam sterilizer for dairy utensils which insures consistently good sterilization day after day with a relatively small connected wattage and low power consumption. A new type of latent steam boiler has also been developed for dairy use. It consists essentially of a well-insulated electric water heater from which quantities of live steam can be drawn after a period of automatic heat accumulation. The boiler will provide both superheated water and steam, and is particularly adapted to regions where flat rates for water heating are in vogue. The equipment was given its start by the Pacific Power and Light Company, and the units are offered for sale by a number of manufacturers both east and west.

The electric tractor has now made its bow to the market as a commercial machine. It is offered by Camillo Sacerdoti P.C., Milano, Italy. In appearance it is much like a large wheel type gas tractor. Energy is supplied to the 35-hp motor through a flexible insulated cable which feeds into the tractor over a sheave at the rear of the driver's seat, the cable being taken up from or laid on the ground as the tractor moves forward and back across the field.

Two new developments in wiring should interest the agricultural engineer. One is the approval last March by the National Fire Protection Association (the body which drafts the National Electrical Code) of non-metallic sheath cable for farm use. This type of cable has found considerable favor for use in barns and poultry houses. It is flexible and may be easily attached to timbers with straps. It has an added margin of safety against current leakage injurious to animals, and it seems to be durable and to stand moisture well. In the past it had been officially excluded from use in all except "continuously dry locations."

The other development is the test installations in several sections of the country of concentric, bare neutral wire. This wire has one conductor surrounding the other, within a lead sheath, the assembly being about the diameter of a lead pencil. Special universal outlet boxes aid in simplifying its installation. The outer sheath of the cable is itself a part of the neutral conductor, and hence all connected metal parts of the system are grounded. A feature of particular interest for farm installations is the ease with which this wire can be installed in old buildings. It need not be insulated from anything, and it may be poked and fished through holes and hidden in corners where other wire could not find space. When and if approved for farm use, it should help materially in breaking down one of the barriers to rural electrification—the cost of adequate wiring.

## PROGRESS IN REDUCING COST OF RURAL LINE CONSTRUCTION

Continued progress is being made in reducing the cost of rural line construction. Two methods have been most promising. The first is in lengthening spans on straight runs with few customers per mile. Spans of 300 ft are common, and some are to be found considerably in excess of this. The other means of stretching the dollar is through the use of higher secondary voltages. The increase in cost of a 6900-volt line over that of a 2300-volt line is reported as approximately 14 per cent, while the increase in capacity is 800 per cent.

Handbooks are not a new subject to this society. In fact a "handbook" has been the conversational literature of the organization since my membership wore knee pants. Now the rural electrificationists have one—at least the C.R.E.A. has one. Several weeks ago notices were mailed stating that sections of the rural electrification handbook on silo filling and water supply were available to all those having fifty cents. J. P. Schaenzer of the University of Wisconsin has been engaged in writing a text on rural electrification particularly for Smith-Hughes teachers. Clyde Walker and Clarence Hurd, A.S.A.E. members from Oregon State College, are probably the first to give a radio course in rural electrification for Smith-Hughes classes in high schools. The course was given last winter, and the accompanying lesson sheets comprise an excellent reference on farm use of electricity.

For a number of years Congress has been heaving legislative boomerangs at the federal government's white elephant at Muscle Shoals. Recently one of these hit the mark, and the country is waiting to see whether the captured elephant is to be further fed on gold, or whether he can be stirred into activity to lift the burdens of surrounding un-electric-enlightened territory.

The Norris bill which was signed by President Roosevelt on May 18, 1933, contains this wording: "In order to promote and encourage the fullest possible use of electric light and power on farms within reasonable distance of any of its transmission lines the board in its discretion shall have power to construct transmission lines to farms and small villages that are not otherwise supplied with electricity at reasonable rates, and to make such rules and regulations governing such sale and distribution of such

The past year has seen a considerable development in electric soil heating, and this promises to be a very popular use for electricity

electric power as in its judgment may be just and equitable; Provided further, That the board is hereby authorized and directed to make studies, experiments, and determinations to promote the wider and better use of electric power for agricultural and domestic use, or for small or local industries, and it may cooperate with State governments, or their subdivisions or agencies, with educational or research institutions, and with cooperatives or other organizations, in the application of electric power to the fuller and better balanced development of the resources of the region."

Any discussion of the merits of the federal government's entrance into the power business is aside from the purpose of this presentation. It is a fact that the government has not seen fit to participate actively in the educational work of assisting farmers to use electricity. This has no doubt been due in part to the fact that electricity is sold by private companies and that some of these have been under almost constant federal investigation since rural electrification was conceived. Now it is written into the law that the government is not only authorized, but is directed to make "studies, experiments, and determinations." With ample, unused power available and great resources behind it, the government has an opportunity to go much further into the problem of the farm use of electricity than has been done in the past, and the rim of the Tennessee Basin is not so high as to prevent any discoveries from getting over.

## FACTS ABOUT MUSCLE SHOALS OF INTEREST TO ENGINEERS

In 1915 Muscle Shoals was a shallow place in the Tennessee River at Florence, Alabama, especially attractive to the mollusca known as muscles. The shoals no longer exist. They have been submerged under a hundred feet of water impounded by Dam Number 2, known also as the Wilson Dam. The muscles have probably perished as a result of the changed environment, but Muscle Shoals has continued to live as a name—a barnacle on the ship of state. The dam and power installation at Muscle Shoals is only a small part of the proposed complete development of the Tennessee River and its tributaries. Approximately two hundred dams for power, navigation, and flood control are indicated on the U. S. Army maps.

Plans for engineering works on the Tennessee River and its tributaries have been prepared by the engineer corps of the Army. The primary intent of the work was for navigation and flood control. The addition of power development has resulted in alternate plans. There probably is no section of the United States where such thorough and detailed studies have been made and plans of development worked out. These investigations have been under way for many years. Some of the stream flow records are continuous since 1887. Tentative designs have been made and published for practically every possible dam, spillway, canal, lock, power plant, and other engineering work in the area. Foundation borings have been made at many sites. The erosion from the entire watershed has been computed to be one inch in 534 years. Flood magnitude and recurrence data have been compiled in great detail. The runoff, deep percolation, surface soil storage, and transpiration of rainfall have been closely estimated.

In 1929 there were twenty-three hydroelectric plants of 370 kw capacity or greater in the basin, and twenty smaller installations, with a total installed capacity of 416,000 kw. The government plant at Muscle Shoals has an installed turbine capacity of 184,000 kw. Because of differences of political opinion, the plant has been used to only a small percentage of its capacity, the Army engineers reporting development of 46,000 kw between 1925 and 1929. The proposed Cove Creek Dam, now under discussion, is in northeastern Tennessee in the far end of the watershed from Muscle Shoals and near the Kentucky and Virginia borders. The site of this dam is on the Clinch River, one of the large tributaries of the Tennesee. Its main purpose is flood storage to even out the very erratic flow of the main river and thus enhance the power development at Muscle Shoals and at other points along the river. A power plant at Cove Creek is also planned.

## TIMES ARE PROPITIOUS FOR THE TENNESSEE VALLEY EXPERIMENT

The Tennessee Basin above Muscle Shoals embraces an area of 19,712,000 acres in the five states of Tennessee, Alabama, Georgia, North Carolina, and Virginia. Some 12,000,000 acres are in privately owned farms. Of this area it is estimated that 6,000,000 acres are good farm lands and the remainder will either be reforested or remain in farm woodlands. Half of the total population of 1,887,000 lives on farms. The average size of the farms is less than 70 acres, and they have poorer buildings, fewer conveniences, and less electric service than almost any other section of the United States. Farming includes livestock, dairying, grain, corn, fruits, and general crops which are fairly typical of much of the United States. Only limited areas are devoted to cotton and tobacco.

Army engineers have estimated that the hydroelectric power generated in the basin can be transmitted a distance of 350 miles at a cost of 2.785 mills per kilowatt-hour, which with the estimated generating cost of 4.34 mills would make the cost of power delivered to receiving substations about 7.12 mills per kilowatt-hour. Territory within 350 miles of the probable generating plants includes all of the area from south-central Indiana to Florida, and from western Missouri to the Atlantic Coast.

The revamped Norris Act gives the government almost unlimited authority to promote social, industrial, and rural development in the Tennessee Valley, as well as the development of power, the protection from floods, and the reforestation of large areas. It has been spoken of as a grand experiment. Times are propitious for such an experiment. The general results will be awaited with interest. That phase which calls for study and experiments in rural electrification should, under proper guidance, be helpful to all sections of the country.

One other legislative act in the "New Deal" has possibilities of interpretation which may mean something to farmers and to agricultural engineers. The National Industrial Recovery Act, carrying a $3,300,000,000 appropriation of funds for public works, provides for the construction of electric transmission lines. It is possible that this may provide an impetus to rural service.

The rural electrification development is still young. It was a war baby, conceived in strife to determine whether the farmers could be served and the power companies still pay dividends. In the first few years, true to baby-

hood, he shook the things that rattled loudest, grabbed for the bright objects, and cut his teeth on everything that came in hand. He passed successfully through the "Gimme a nickel, Dad" stage, and has asked as many questions as any precocious lad should. Whenever he saw anyone pushing a lawn mower or turning a sausage grinder, he's been on hand and edging in with a "lemme turn it." He's ten years old now. He's been helpful to dad and mother, and has experimented on a few model airplanes.

But youth is usually not very profound. While industry has been developing and using X-rays, thyratrons, and photo-electric cells, we have been busy with the more immediate problems of line construction and wiring. While the medical profession has been devising electrical knives for surgery, ray treatments, cancer cures, and the production of artificial fevers for the cure of other maladies, we have been adapting electric drives to existing machinery. This is a logical development, but it leaves much for the agricultural engineer to do in the future. There is probably no more complex industry of large proportions in which electrical energy might be used for such a wide variety of purposes, than agriculture. It includes the whole realm of plant growth with its need for mechanical manipulation of the soil, for stimuli in the form of light, heat, and moisture, and in release of plant food. It includes animal production with its problems of air conditioning, feed preparation, health, and the care and storage of animal products. The one problem of control of crop pests, in which electricity has made some progress, involves a possible annual saving of several billions of dollars of crop damage.

With the reduction of farm prices and farm incomes, and the disappearance of bank balances, has also come a changing conception of farming. In place of measuring all returns in terms of money profits, more attention is being given to other remunerations of farm life. These include electricity; not merely the radios and electric fans, but those methods of doing work which eliminate drudgery and add pleasure to the task.

Utility and manufacturing executive interest is not as keen on rural business as on railway electrification or the urban domestic load, and this in spite of larger potential load on the farm. Can it be that we have not yet found our stride in rural electrification, and are not demonstrating how to unlock this farm load or how the farmer can be provided with service? Some parts of a rural electrification structure have been made. So far they have not been effectively put together. Much of the missing accomplishment lies in our own field of agricultural engineering.

# Field Observation of Soil Erosion Index Variants[1]

By J. T. Copeland[2]

THE "Natural Principles of Erosion," reported before meetings of the American Society of Agricultural Engineers, and as described in Mississippi Extension Bulletin No. 34, are now more appropriately designated the "Soil Erosion Index." The "Soil Erosion Index," as evolved in Mississippi, refers to the correlation between (1) the absolute terrace location[3]; (2) the reciprocal grade[4], and (3) the natural drainage direction[5], coincident with the respective erosion planes characteristic of a given soil.

The agricultural practices in Mississippi, together with the climatic conditions, offer a wide range of variables to influence the behavior of a soil, of which there are ten general areas and more than 150 types. There are fields which have been in the same clean cultivated crop for more than 100 years, while near by are virgin soils being cleared for the plow. Records show climatic extremes in temperature from 8 deg F to 106 deg F, with precipitation ranging from 37 to 72 in per annum.

Field observation of the reaction of these many variables and their response to the soil erosion index method of determining terrace location, grade, and direction results in the conclusion that

1. Soil components, rather than per cent of slope or soil type, influence the intervals of erosion[6].
2. A soil of a given slope, under uniform cultural practices, may change the erosion interval on that slope either in factors or by multiples of factors[7].
3. A soil formerly with uniform erosion interval may change in response to cultural practices either in multiples or by factors[8].
4. The principles underlying erosion index practices change with the constant physical variants of the soil, and the accuracy with which the erosion indices are interpreted and followed facilitates the precision with which the resultant terrace location, grade, and direction coincide with the erosion planes or belts peculiar to the particular soil[9].

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[1]Paper presented at a meeting of the Southern Section of the American Society of Agricultural Engineers, at New Orleans, La., February 1 to 3, 1933.

[2]Extension agricultural engineer, Mississippi State College. Mem. A.S.A.E.

[3]The absolute terrace location is described as the upper perimeter of the erosion head, either sheet washing or gullying, which requires the services of a terrace to stop soil movement. Minor erosions which might be arrested by contour cultivation, the use of cover crops, the application of organic matter, liming, deep plowing, etc., are not considered as absolute terrace locations.

[4]The reciprocal grade is indicated by the elevation interval between adjacent absolute terrace locations—the number of feet interval designating the number of inches constant grade per 100 ft of terrace.

[5]The natural drainage direction extends the terrace away from the water dividing ridge and leads across the face of the slope to the natural surface drainage outlet.

[6]Erosion intervals of 2 ft have appeared with slopes of 1, 2, 3, 4, 5, and 6 per cent in the following soil series: Orangeburg, Lufkin, Houston, and Oktibbeha of Mississippi, and Putnam silt loam of Missouri. (In the case of the last named, see the August 1931 report of Missouri Soil Erosion Observation.)

[7]Rolling clay cornfield on Highway 63, four miles south of Columbia, Mo. First erosion plane 3 ft under crest of hill definitely intercepted six major erosion heads with a 3-in grade per 100 ft. (Major erosions require fills for traverse of terraces and for the travel of the more cumbersome harvesting machines.) Second erosion plane 3 ft under first erosion plane intercepted three minor erosions. (No terrace needed.) Third erosion plane 6 ft under first needed terrace line indicates 6-in grade to 100 ft which intercepted ten major erosion heads. The second 6-ft interval and 6-in grade per 100 ft arrests three major erosions. In this particular field the surface soil had less depth on lines of minor erosion and depositions immediately above the major lines, which in Mississippi would indicate the need of contoured cultural practices conforming to terrace lines, the lack of which would eventually necessitate terraces on both major and minor lines as a result of continued erosion losses as contributed to by exhaustive farming practices.

[8]J. C. Wooley's erosion field, 5½ miles southeast of Columbia, Mo., 4 miles south on Highway 63, and 1½ east. Erosion indications were of 4-ft vertical intervals and manifested a general requirement of terraces of 4-in grade per 100 ft on all erosion planes. In areas of subsoil outcrop on the steeper slopes erosion heads appeared in intervals of 2 ft. This condition no doubt would be arrested by terracing, contour farming, and the addition of organic matter in these areas. The small gully formations of this field were peculiar, in that many erosions were in straight lines with right-angle turns fostered by straight-row cultivation and the location of plow-land water furrows.

[9]Putnam silt loam erosion heads were difficult of precise location due to the general uniformity of color in surface and subsoil, whereas the soils of Mississippi show rather distinct color variations between surface and subsoil. Possibly the most satisfactory method of recognizing the upper apex or arc of an erosion on this soil is arrived at by lowering the point of vision to a point level with and oblique to the erosion concavity and thus locating a marker at its upper perimeter.

# The Canvas Hose System of Irrigation[1]

By George Amundson[2]

UP TO about three years ago irrigation was not considered a very important problem in Michigan, especially for the average field crop. Overhead systems of irrigation have been in use in the state for many years by truck gardeners, and to some extent by small fruit growers, and they are proving satisfactory for these crops, even with comparatively high initial costs.

Ordinarily we assumed that our annual rainfall of 32 in was ample to supply our average crops, but during the extremely dry years of 1930 and 1931, inquiries began to pour in from farmers throughout the state for information on methods of emergency irrigation. We felt that some method should be worked out for the people who were fortunate enough to have a source of water running through their farm. The problem was assigned to O. E. Robey of the department of agricultural engineering at Michigan State College, who developed what we call the "canvas hose method" of irrigation.

As we observed the results of a small amount of irrigation, we began to study the rainfall records to see if there was a place for irrigation in Michigan during other than the years of extreme drought. We found that the rainfall for the state was very irregular; the distribution throughout the year was such that it did not provide enough moisture during the growing season. The records of total rainfall for the growing months showed that the average for June, July, and August was only about 6 in, and that in many years it was below that. Charting the record of rainfall by days, we found that every year there were one or more periods of ten days to two weeks of dry, hot weather that very materially checked the yield and quality of many crops. Moreover, these rainfall records included a great number of very small rains of ¼ in or less that were of little benefit to crops.

While the irrigation of truck crops has been more or less standard practice for years, and results have proven profitable, it seemed necessary to determine whether or not it would be possible to irrigate ordinary field crops with profit. Two years ago Mr. Robey selected five plots of potatoes in different sections of the state and made regular applications at the rate of one acre-inch per week. The rainfall was recorded in each location, so there was a complete schedule of the water available for the crop. The results of this experiment are indicated in Table I.

The interesting thing was that in each plot, with rather small applications of water, large increases in yield were secured, and of particular interest was the fact that most of the increase came in potatoes that would grade U.S. No. 1. Referring to Table I, it will be seen that the increases ranged from 66 to 128 bushels. Another thing that was brought out in these experiments was the fact that in some of the plots it was too late in beginning the application of water to secure maximum benefits.

Last year ten acres of potatoes at the Lake City experiment station in the northern part of the state were irrigated in various ways by the canvas hose system of irrigation. Some of the plots were given one acre-inch of water per week, some two, and some were irrigated as needed. No particular method was used on this plot to determine when irrigation was necessary. It was left to the judgment of the superintendent of the station when water should be applied in order to put it on an average farm basis. The results of his experiment are given in Table II.

We found that, in spite of a little more than normal rainfall in that section, we were able to secure a large increase in yield, and the quality was greatly improved. During the past season the same method has been used by farmers throughout the state on strawberries, truck gardens, and other crops. While none of these were carried on as experiments to accurately check yields, the reports from the owners have been practically uniform in that they increased their yields from 25 to 100 per cent, and the quality was greatly improved. Particularly on strawberries were they able to lengthen the picking season and secure the benefit of improved market prices. We believe also that the experience of Mr. Dutton of Ohio and others in irrigating orchards has proven that they will respond to irrigation as quickly as any crop grown.

* * * *

What you are probably particularly interested in, judging from the inquiries we have received, is how this can-

[1]Paper presented at the Land Reclamation Division session of the 27th annual meeting of the American Society of Agricultural Engineers, Purdue University, June 1933.

[2]Extension agricultural engineer and project leader, Michigan State College.

**Table I. Results of 1931 Canvas Hose Irrigation Experiment**

| | Yield in Bushels per Acre | | | | Rainfall, inches | Irrigation, inches (1 in per application) | Total water, inches |
|---|---|---|---|---|---|---|---|
| | No. 1 | No. 2 | No. 3 | Total | | | |
| Plot No. 1 | | | | | | | |
| Irrigated | 249.2 | 31.68 | 22.4 | 303.28 | 11.71 | 6 | 17.71 |
| Unirrigated | 129.64 | 35.84 | 15.76 | 181.24 | 11.71 | | 11.71 |
| Increase | 119.56 | −4.16 | 6.64 | 122.04 | | | |
| Plot No. 2 | | | | | | | |
| Irrigated | 80.895 | 41.999 | 17.73 | 140.602 | 10.51 | 4 | 14.51 |
| Unirrigated | 22.385 | 35.436 | 16.25 | 74.07 | 10.51 | | 10.51 |
| Increase | 58.510 | 6.563 | 1.48 | 66.532 | | | |
| Plot No. 3 | | | | | | | |
| Irrigated | 145.018 | 31.883 | 9.498 | 196.080 | 10.51 | 4 | 14.51 |
| Unirrigated | 28.496 | 38.677 | 11.435 | 68.607 | 10.51 | | 10.51 |
| Increase | 116.522 | 3.206 | −1.937 | 128.483 | | | |
| Plot No. 4 | | | | | | | |
| Increase | 103.25 | −1.05 | 2.33 | 104.53 | | | |
| Irrigated | 204.40 | 18.31 | 6.69 | 229.4 | 14.66 | 7 | 21.66 |
| Unirrigated | 101.15 | 19.36 | 4.36 | 124.81 | 14.66 | | 14.66 |

**Table II. Results of 1932 Canvas Hose Irrigation Experiment**

| Plot | Yield in Bushels per Acre: U.S. No. 1 | U.S. No. 2 | U.S. No. 3 | Total | Inches water | Inches rain | Total inches of water |
|---|---|---|---|---|---|---|---|
| **Irish Cobblers** | | | | | | | |
| No. 1—1 in | 237.1 | 22.3 | 8.0 | 267.3 | 5.0 | 13.9 | 18.9 |
| No. 2—check | 183.1 | 30.6 | 11.3 | 225.3 | | 13.9 | 13.9 |
| Increase | 54. | 8.3* | 3.3 | 42.0 | | | |
| No. 3—2 in | 270.0 | 20.0 | 9.4 | 299.7 | 6.8 | 13.9 | 20.7 |
| No. 4—check | 168.6 | 22.1 | 11.7 | 212.5 | | 13.9 | 13.9 |
| Increase | 101.3 | 1.8* | 2.3* | 97.2 | | | |
| No. 5—2 in** | 274.0 | 23.4 | 5.7 | 303.1 | 4.6 | 13.9 | 18.5 |
| No. 6—check | 213.4 | 34.8 | 9.6 | 257.8 | | 13.9 | 13.9 |
| Increase | 60.6 | 11.3* | 3.9* | 45.3 | | | |
| **Russet Rurals** | | | | | | | |
| No. 7—1 in | 393.1 | 33.8 | 3.6 | 430.5 | 5.5 | 14.1 | 19.6 |
| No. 8—check | 310.9 | 54.5 | 10.9 | 376.2 | | 14.1 | 14.1 |
| Increase | 82.2 | 20.7 | 7.3* | 54.3 | | | |
| No. 9—2 in | 359.4 | 37.0 | 2.9 | 399.3 | 9.0 | 14.1 | 23.1 |
| No.10—check | 225.1 | 40.7 | 7.3 | 273.0 | | 14.1 | 14.1 |
| Increase | 134.3 | 3.7* | 4.4* | 126.3 | | | |
| No.11—2 in** | 270.7 | 18.72 | 7.3 | 296.1 | 2.4 | 14.1 | 16.5 |
| No.12—check | 188.8 | 39.9 | 7.3 | 236.0 | | 14.1 | 14.1 |
| Increase | 81.9 | 21.8* | | 60.1 | | | |

*Decrease instead of increase.
**As required.

vas hose system of irrigation works, and what its possibilities and limitations are. When Mr. Robey started developing this method of irrigation, we began to hear that this one and that one in different parts of the country had used canvas hose to irrigate in many different ways, ten, fifteen, or twenty years ago. While we do not claim any particular originality in the idea of using canvas to convey water for irrigation, we are at least making it work; and we can claim credit for tying a knot in the tail of the hose, which pretty largely marks the difference between making this system work and not. It has been rather interesting to us that this year particularly we have been receiving a number of inquiries as to how to build up the hose and how to use this system, from states and sections where the system was tried a number of years ago. Anyway, to meet the particular conditions with which we are confronted in surface irrigation in Michigan, we have found it an inexpensive and practical method, but which of course has its limitations.

From studies we have made it appears that all different systems of irrigation work about equally well whether it be overhead, sprinkler heads, flooding or trenching, or subirrigation, but that each has its limitations. Irrigation by trenching is probably the least expensive where it can be used, but because of rolling topography and the porous types of soil, it is impossible of application in all but a few sections of Michigan.

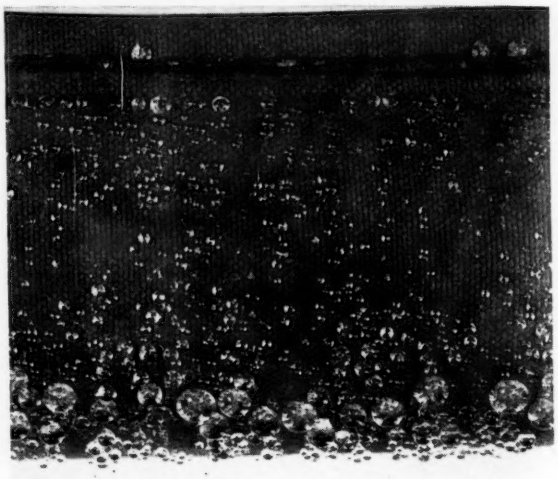
If I were to try to define the canvas hose system of irrigation, I would say that it is essentially the same as a furrow or trench across the field standing full of water, and the water seeping out throughout the entire length. In using the canvas hose we do the same thing as putting the water in a trench across the field, with this difference: Irregularities in the field do not make any particular difference. The hose is layed usually between each row of the crop that is being irrigated, closed at the end, and as the water is pumped in it fills the entire length of the hose. When a slight pressure is built up, the water begins to seep out slowly throughout the entire length of the canvas tube.

This system is essentially the same in planning equipment as any type of surface irrigation. In other words, the pressure required is unimportant, but a rather large quantity of water is necessary. For this reason the investment in equipment is usually very small for the area that can be covered, particularly in the sections where we have been advising irrigation, that is, where an inexpensive source of water, either in a lake, stream, or shallow well, is available.

## SUCCESS OF SYSTEM DEPENDS ON MANIPULATION OF HOSE

The hose we have been using was made out of different weights of canvas, namely, 8, 10, and 12-oz duck. The canvas is cut into strips about 9 in wide, and sewed up with the seam lapped over to add strength. This makes the tube about 2½ and 2¾ in in diameter when completed.

It has been my observation, after carrying on demonstrations last year and this year in some thirty counties of the state, that the success or failure of using this system of irrigation depends pretty largely on the manipulation of the canvas hose. We can, with this system, go over considerable irregularities in the field and still keep the seepage fairly uniform. To do this, more than one weight of canvas is necessary. In other words, where we are pumping the water up against a slope of 3 or 4 ft across a 400 or 500-ft field, we would probably have to use three weights of canvas. In the lower end 12-oz duck would be used, next some 10-oz, and in the far end some 8-oz duck. About one-third the length of the row for each weight will usually give quite uniform seepage. Where there is a depression in the middle of the field it is necessary to put heavy canvas in the hollow, and to lead up over the rise on the other side, and probably a lighter weight on either end. The building up of the proper weights of canvas is an individual problem for each field, but usually once it is adjusted it will cover the field that is being irrigated during the season without any further adjustment. Sometimes heavier than 12-oz canvas is necessary. It may be that pieces of No. 8, or even No. 6, canvas are needed to prevent excess leakage in the low part of the field.



This picture shows a section of canvas hose used for irrigating purposes. The bubbles indicate seepage of water from the exterior surface

Mr. Robey has worked out a system of treating ordinary canvas with asphalt combinations, which not only helps to preserve the canvas, but makes the seepage for any weight slower. It also makes possible better adjustment of the leakage on rough ground. He has also made watertight conveying hose out of heavy canvas by treating it with asphalt. This in many cases makes it possible to build a tube of canvas large enough to get capacity with a small friction loss at much less cost than large pipe. It also makes the outfit more flexible and portable. The use of round, woven fabric tubes, that he has been testing, seems to offer great possibilities.

We have found that while pressure is relatively unimportant (2 or 3 lb pressure is usually sufficient to keep a long line of hose operating), the quantity of water applied for a given length of hose is important for satisfactory operation. This will vary with different types of soil, and the rate at which the soil will absorb the water; but generally we find that there should be a capacity of about one gallon per minute available for each ten feet of leaking hose in use. In other words, if a man is running a line 500 ft long, he should have a capacity of about 50 gpm. This can be varied, depending upon conditions, probably 50 per cent either way, but if too long a line of hose with a smaller amount of water is used, there is difficulty in keeping the entire length full, which prevents even seepage. On the other hand, if too much water is put through a given length of hose, the leakage is increased, and there is trouble with running and flooding in the rows. In my opinion the ideal method of applying water with this system is to have enough leaking hose out to take the full capacity of the pump at a rate at which the ground will just absorb it without running or flooding in the rows. When properly used, this system is very economical in the use of water, because it is applied directly to the ground and immediately absorbed, which provides opportunity for very little loss by evaporation.

Ordinarily the canvas tube is laid in each row and left long enough to apply one or two acre-inches, or whatever quantity is desired; then it is moved over into the next row. This is not nearly as much of a problem as it would seem. From our experience last year at the Lake City station, and the experience of other men in the state, we feel it is possible for one man with enough equipment

**Table III. Estimated Cost of Irrigating with Canvas Hose**

(Prepared by O. E. Robey from 1932 experiments. The data includes the probable cost of irrigating an area large enough to take one man's full time.)

| | |
|---|---|
| Average kilowatt consumption per acre-inch | 26.28 |
| Cost at 2 cents per kilowatt | $ .5256 |
| Average man-hours per acre-inch | 2.37 |
| Cost at 15c per hour | .35 |

Equipment Used

| | |
|---|---|
| 5-hp electric motor | $ 50.00* |
| Centrifugal pump | 48.00 |
| Pipe fittings, etc. | 20.00 |
| Pipe line, 1250 ft., 2½-in | 125.00 |
| 600 ft canvas hose | 30.00 |
| | $273.00 |
| Interest, 3 per cent | $ 8.19 |
| Depreciation on pipe line, motor and pump, 15% | 36.40 |
| Depreciation on hose, 33⅓% | 10.00 |
| | $54.59 |

(This equipment capable of delivering 10 acre-inches per week for 10 weeks; hence, on 100 acre-inches, annual overhead charge of $54.59, or $.55 per acre-inch.)

From the above, the cost per acre-inch would be

| | |
|---|---|
| Current | $ .53 |
| Labor | .35 |
| Overhead | .55 |
| | $1.43 |

Cost per Bushel Increase in Each of the Plots

| | Increase | Water | Cost per inch | Total | Cost per bu. |
|---|---|---|---|---|---|
| Plot 1 | 54.00 | 4.97 | 1.43 | 7.11 | .131 |
| 3 | 101.35 | 6.81 | 1.43 | 9.74 | .096 |
| 5 | 60.59 | 4.61 | 1.43 | 6.59 | .108 |
| 7 | 82.20 | 5.47 | 1.43 | 7.82 | .095 |
| 9 | 134.30 | 8.99 | 1.43 | 12.86 | .096 |
| 11 | 81.96 | 2.35 | 1.43 | 3.36 | .040 |

*Since the motor was used for other work, only a portion of its value is considered.

to irrigate about 30 acres each week—in other words, four to five acres per day. Usually the hose is moved full, by walking in the row where it is to be laid, and lifting the hose hand over hand. Last year we made a large pulley which made this job considerably easier. This is simply a wooden pulley with about a four-inch diameter center, and flanges large enough to hold the full hose. It has a handle on the top, and the man slips the hose into the pulley and walks down in the row, while the hose drops down in place behind him. It is not necessary to empty the hose in order to move it in this manner.

In the experiment on the ten acres of potatoes last year, we were able for the first time to secure some cost figures on the canvas hose method of irrigation. On this particular field it was necessary to use about 1300 ft of pipe to bring the water from the creek to the field, and for the header line along one end. The rows were 40 rods long, and one line of hose was used to irrigate the entire tract. Table III gives the cost of the equipment, the annual overhead charge, and the cost per bushel increase. The charge of $50.00 for the 5-hp motor probably needs some explanation. This was a farm motor that was used in other operations on the farm, and it was the superintendent's estimate that this much of the initial cost should be charged to the irrigation equipment. This equipment was capable of handling 10 acre-inches per week, and on the basis of 10 weeks, or 100 acre-inches, makes an annual overhead charge of $54.59, or 55 cents per acre-inch. The labor cost is based on actual time of moving the hose. The current consumption of 53 cents per acre-inch is the actual cost with current at 2 cents per kilowatt-hour.

I would not want to leave the impression that we consider this the only satisfactory method of irrigation. As I said before, I believe that all methods are about equally satisfactory when used in their proper places. Nor would I want it understood that this canvas hose system of irrigation is absolutely perfect in every respect, or that it will work under all conditions. There is a limit to the irregularities in the field over which the hose can be laid and secure satisfactory seepage. It does require some labor in moving and handling the hose, but we have found it a very practical and relatively inexpensive method to meet the particular conditions with which we are confronted in Michigan; and it has made surface irrigation possible that was out of the question by any system of ditches. It has another advantage, in that it is portable and can be moved to different fields, which makes it practical for use on crops that are rotated. We feel that the results secured during the past two years have been encouraging enough to justify spending considerable time and effort on this project.

# Perspective Drawing Simplified

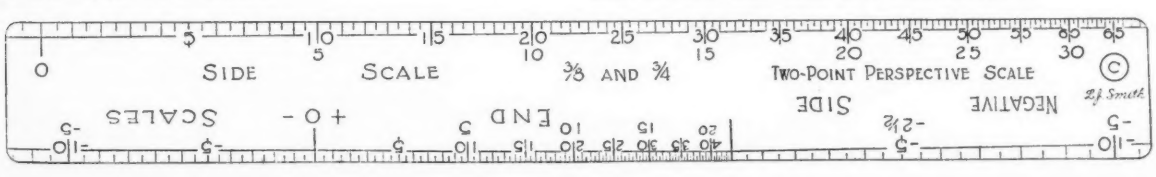
By L. J. Smith[1]

THE methods of developing a perspective drawing are rather involved, requiring the projection of numerous points to the picture plane and thence down to the perspective itself. I have worked for some years in the endeavor to simplify the process. The first attempt was that of developing an adaptation of the isometric cross section paper idea, except that the lines converged toward the two vanishing points on the line of the horizon. This proved too complicated. It necessitated so many lines that they were difficult to follow.

The next step was that of developing a set of perspective scales. This proved more successful. A scale was developed for measuring distances along the side or front, and one for measuring along the end of the object or building at the ground line. With these scales it became possible using a standard set of vanishing points, and the corresponding architectural scale for vertical distances, to quickly draw in the side and end of the object directly in the perspective without resorting to projection.

I am arranging to have these scales reproduced at a nominal cost in order that they may be introduced and used by those interested in this kind of drawing. A brief set of mimeographic instructions will go with the scales, which are 12 in long, one being ¼ and ½ in to the foot, and the other three-eighths and three-quarters scales. When making drawings of small objects the same scales may be used, but letting ¼ in equal 1 in, etc. Perspective scales have been developed and copyrighted also for single-point perspective drawing. They will be reproduced later after the two-point scales have been introduced.

[1]Head, department of agricultural engineering, State College of Washington. Mem. A.S.A.E.



# Methods of Field Plot Investigations with Cotton Production Machinery[1]

By John W. Randolph[2]

THE FIELD plot experiments described in this paper are a part of a cooperative investigation conducted by the Bureau of Agricultural Engineering, U. S. Department of Agriculture, and the agricultural engineering departments of the Alabama and Mississippi agricultural experiment stations. The objects of the field studies are to determine the effects of tillage machine operations on the growth of the cotton plant, to find the most economical methods of utilizing this machinery, and to furnish a basis for the development of needed equipment. These investigations are supplemented by special field tests and by laboratory and greenhouse studies of soil dynamics and tilth.

This program is not confined to an economic study of cotton production machinery and its uses under different soil, topographic, and climatic variations, but it is designed to determine cause and effect relationships. In this it follows the precepts of Hall (1)* who states in the preface to his book on the Rothamsted experiments that "Experiments which aim only at ascertaining how to derive the greatest monetary return from a given crop, however necessary they may be, are only of value for a short time and for the particular soil and locality where they are carried out." This statement indicates that one of the aims of the Rothamsted field experiments is primarily to find out why certain results are obtained.

In planning these field experiments consideration was given to the available basic information on the ecological and physiological requirements of the cotton plant. From a survey data were collected on the many methods and schemes for the use of machinery in cotton production. The first step in determining cheaper machine methods of producing cotton was to determine how machine operations in the field might modify the environmental factors of the cotton plant. The methods of study used by the agronomists served as a guide in planning the field experiments.

The agronomists, in similar studies, use a carefully determined plot technique which involves a system of small plots with numerous checks and a number of replications. The effects of factors beyond control, such as soil variation and insect damage, are averaged by the use of replications of the experiment. The basis for comparison of any series of plots or experiments is obtained by check plots repeated frequently across a series of plots.

The size of a plot is determined by the type of investigation to be made and by the assumed accuracy with which it can be conducted. Compiled results of different investigators show variations in recommendations with some common conclusions. According to Love (2), "Five plots of 1/200 acre each, other things being equal, will give greater accuracy than one plot of 1/40 acre. Long, narrow plots that extend in the direction of the greatest variation in soil are more reliable than shorter and wider, or square plots." The results of McClelland (3), as described by him in a lengthy discussion of plot variability, show that a desirable size of plot ranges from 1/45 to 1/5 acre in which range he shows a difference in error of 2.2 per cent. Summerby (4) reports: "There is a steady and rapid increase in accuracy as the number of repetitions is increased. The most rapid increase in accuracy is got as the number of repetitions is increased to four." One common conclusion of these investigators is that smaller plots, repeated at intervals, are best. The question of size, however, is still a live point of discussion with the agronomist.

The agronomy department of the Alabama station, in its soil fertility experiments with cotton, makes each plot six rows wide with a 7 to 10-ft crop guard at the ends. The yields of the four center rows only are used in the calculation of yield data. The area of each plot is 1/30 acre duplicated and replicated on as many soil areas as possible. There seems to be no reason for departing greatly from this field plot method in agricultural engineering experiments.

The practical use of the average drawbar dynamometer requires a minimum of 50 ft for a test. To increase the accuracy and to reduce the percentage of a draft-chart record representing end-border effects, the plots should be 150 ft or more in length. Consequently, on the Prattville experiment field of the Bureau of Agricultural Engineering, plots of 1/13 acre each, having a length of 167 ft, were used.

Field machine units for cotton production, while represented by many makes, models, types and sizes, have certain common groupings of the basic elements of design. In each group some implements are adaptable to and meet the requirements of field plot experiments. For instance, in practice a four-row cultivator is a multiple of the half-row unit. In a cultivation-method experiment, the use of a one-row riding cultivator has the advantage over larger units, because it can be changed quickly from one set-up to another and has all the necessary controls.

Once the kind of implement and the method of use on a given soil are determined, it becomes largely a matter of mathematical calculation to determine the most economical size to use. However, the assumed uniformity of work with one or a multiple of like units should be substantiated by tests which are supplementary to the field experiments.

In the following discussion the plan of work on the Prattville Experiment field will be described and explained in some detail. Work of a similar nature is being done on other experiment fields as a part of the cooperative program between the Bureau of Agricultural Engineering and the Alabama and Mississippi stations.

The Prattville experiment field, which has a soil classified as Greenville fine sandy loam, is laid out for a study of the three phases of machine utilization in cotton production, namely: seedbed preparation, planting, and cultivation. The general agronomic principle of plot work of varying one set of conditions while holding others constant is used. For example, the plots used in studying the effects of different methods of cultivation are prepared and planted alike. All plots on the field receive the same fertilizer applications and are planted with the same variety and amount of cotton seed. The field arrangement, as shown, in accompanying diagram, consists of six series of experiments, as follows: Series 100, methods of cultivation; Series 200, method of cotton planting; Series 300, use of cross-row cultivation units; Series 400, combined methods of seedbed preparation; Series 500, deep methods of common seedbed preparation as practiced by the farmers in the South; Series 600, the same methods as in Series 500 at shallower depths.

The seedbed preparation methods used in Series 500 and 600 take into account various uses and combinations of uses of standard tillage implements at different sea-

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[1]Paper presented at a meeting of the Southern Section of the American Society of Agricultural Engineers held in New Orleans, Louisiana, February 1933.

[2]Agricultural Engineer, Bureau of Agricultural Engineering, U.S. Department of Agriculture.

*The figures in parenthesis refer to the bibliography that follows this paper.

sons. The amount of work varies from a minimum of one shallow operation of the spring-tooth harrow to a maximum of well-pulverized soil to a depth of 22 in under the row. The plan of experimentation involves the "pair-plot" method. For example, one combination of machine utilization is paired as to like operations at different seasons. Any plot on Series 500, with its deep seedbed preparation, has a corresponding plot on Series 600 with similar operations at a shallower depth. The system is likewise extended to study the effects of combinations of factors.

The plans used in the study of seedbed preparation methods and machine utilization on Series 500 and 600 include measurements of the weather, the soil, the machines used, the control of weeds, and the cotton plant itself.

A standard system of weather records is kept at the experiment field. The effect of the weather on the soil moisture is obtained by periodic moisture determinations from which data curves are constructed for showing the absorption and retention of moisture with reference to time and to weather. Extra moisture determinations are made at the time of each implement draft test. The percentage of water in the soil is measured by the standard soil physics method; that is, the determination of the percentage of water by weight of the dry (110 deg C) weight of the soil.

Analytical soil measurements are made in the laboratory. They are: A mechanical analysis by the Bouyoucos method modified by Carnes and Sexton (5); soil dynamic properties of shear, resistance to compression, cohesion, adhesion, and heat transfer by means of a method devised by Nichols (6); and soil cementation and crust formation by the Carnes method (7). These measures are made to obtain an idea of what would logically occur in field manipulation of the soil and to explain conflicting data.

Detailed field measurements of the soil are linked as far as possible with machine operation data. Such operation data are obtained through the medium of a dynamometer, which registers the draft requirements of each implement as it is used, and is collaborated with the element of time and distance to bring about an accurate measure of the power expended in each operation.

The character and quality of the work done by tillage implements is obtained by some new methods of measurement and by some old methods modified. The following paragraphs describe these methods and the reason for each.

To measure the efficiency of various tillage implements in pulverizing the soil, Keen's method (8) was modified. Nine sieves were used which varied in diameter of the circular aperture as follows: 4-in, 3-in, 2-in, 1½-in, 1¼-in, 1-in, ¾-in, ½-in, and ¼-in. A representative surface area of a plot is blocked off into a 30-in square by driving four strips of sheet metal, 30 by 12 in, through the disturbed soil. The larger clods within the sample area are carefully removed by hand and distributed into piles as to their failure to pass the 4, 3, and 2-in sieves. Then, within the larger square, a second square one-fourth the area of the large square is blocked out by means of metal sheets. The soil within this quarter is carefully transferred to the set of nested sieves (with pan attached) which comprises the remaining sizes of sieve openings. By a gentle oscillation of each sieve the sample is segregated into the various sizes as represented by diameter of sieve openings. The weight of each soil fraction is transposed into its percentage of the weight of the entire sample.

Keen's "single-value" method of expression of results in terms of "surface area" is replaced by a value called "pulverization modulus" which is merely a modification of the "fineness modulus" described in literature for use in aggregate classification for concrete mixes.

Hool (9) gives the method of determination of the "fineness modulus." Illustration of this method, as applied to soil pulverization, is explained as follows:

| | Per Cent Retained on Each Sieve | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Plot | 4-in | 3-in | 2-in | 1½-in | 1¼-in | 1-in | ¾-in | ½-in | ¼-in | Total |
| 503 | 0 | 2 | 5 | 8 | 10 | 15 | 12 | 8 | 18 | 78 |
| | Summation of Percentages Retained | | | | | | | | | |
| | 0 | 2 | 7 | 15 | 25 | 40 | 52 | 60 | 78 | 279 |

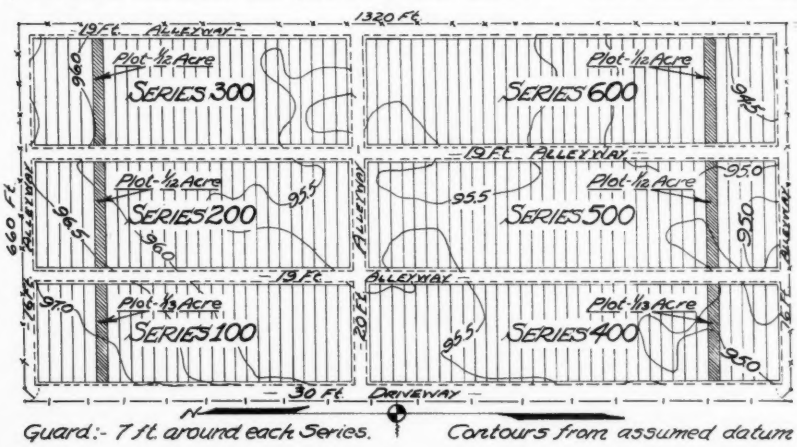
The figure "279 per cent" divided by 100 per cent gives a "pulverization modulus" of 2.79. A soil sample poorly pulverized gives a large modulus value and soil well pulverized a small value.

This method of determination is applicable only to soils which tend to clod. Its use in sands and in extremely wet soils is not practical.

To make a further study of the permanence of a machine's action on a soil and to measure the resulting soil changes due to weathering and other agencies, changes in the soil's consolidation are measured as follows: The apparent specific gravity of the soil is measured to a depth of 6 in on Series 500 and to a depth of 3 in on Series 600. The standard experimental method is to remove a given volume of soil, reduce the weight by its percentage of moisture to an oven-dry condition, and express the "volume-weight" in relation to water. A test made before and after a machine operation shows the effect of the operation on the consolidation of the soil.

Another measure of soil's consolidation is made by determining the elevation of the soil's surface within an established 6-ft square in the center of a plot. A wye level, set on the established bench mark, is used to measure the elevation of 60 points within the square. From these readings the mean surface elevation is determined and the surface contour or cross-section is plotted.

As a check on soil changes and as an aid in the explanation of other data, an isodyne map is made. Keen (8) has shown that the dynamic properties of the soil vary in a




This diagram shows the field arrangement at the Prattville (Alabama) experiment field of the U. S. Department of Agriculture, as it was laid out for study of the three phases of machine utilization in cotton production, namely: seedbed preparation, planting, and cultivation, as set forth in the accompanying paper by Mr. Randolph

field and that these variations account for certain fluctuations on a dynamometer chart. Therefore, it is desirable to obtain from time to time the relative values of the isodynes (i.e., the lines of equal draft), in order to correct or correlate the experimental draft data and to follow the effects of machine operation and other factors on the draft. In locating these subsequent changes a small dynamometer is attached to a chisel or small plow. The use of this instrument requires little space and introduces little or no error in routine plot work. The draft of the chisel in the soil is plotted on a map of the experimental plot on which the test is run and lines of equal draft are traced out as if they were lines of equal elevation.

The secondary value of machine operation is weed control. Data on weeds are obtained by making note of the kind and by counting the number of weeds in an area of 20 sq ft in three representative places in a plot. The rate of weed growth and their successful elimination by machine-use are obtained by successive counts. To reduce the factor of weeds as a variable they are allowed to grow only a few days. The hours of hoe labor required to remove them serves as a measure of the machine operation.

The most important measurements from an economic point of view are those relating to the growth and production of the cotton crop. A stand of cotton is necessary for a good yield. This is checked by actual count at different periods in the plants development which gives the number of seed that germinate, grow, and survive the effects of disease, implements, and other factors. The practice of planting an abundance of seed to insure a stand and then removing the surplus plants divides the study of plant mortality into early and late interpretations.

An intermediate record of the development of the plant is found by measurements, and by noting the date of the development of certain parts of the plant, such as branches, squares, etc.

The final measure of an experiment is the yield of seed cotton and the percentage of lint.

* * *

This description of the field studies of cotton production machinery may not show the true optimum results of any one method of machine use; it will indicate the most profitable methods, which, in later studies, can be investigated by varying the factors involved.

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# A Portable Alfalfa Dehydrating Plant

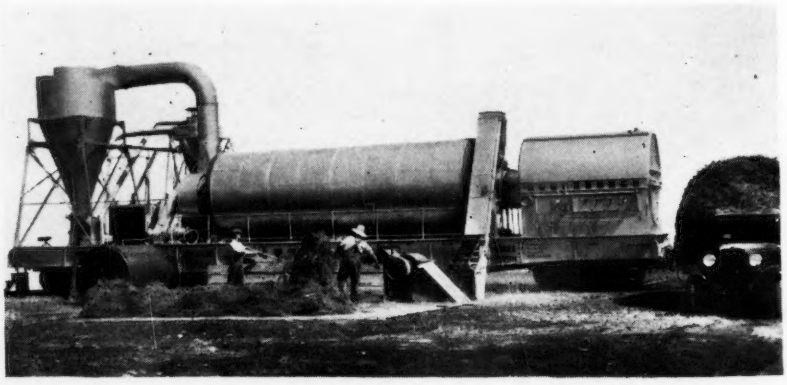
AGRICULTURAL engineers will be interested in the portable dehydrating plant shown in the accompanying illustration. This plant, built by the Heil Company, Milwaukee, is mounted on a flat car and is divided among six assemblies which go to make up the complete unit. At the right of the picture the first assembly is rotary-flame oil furnace.

The new-mown alfalfa is dumped on the receiving platform shown in the foreground, from which it is fed into the chopping machine. From there it is conveyed up and dumped into a rotary receiving hopper where it is automatically discharged into the dryer. The dryer is composed of three concentric drums. The alfalfa and hot air are sucked through these three drums. The total actual travel of the alfalfa as it moves forward through the small drum, then back through the intermediary drum, and forward again through the outside drum, is approximately 60 feet.

At the left end of the flat car is mounted the power units and collecting equipment. A suction fan blows the dried alfalfa up into a collector where it is discharged into a hammer mill. From here the alfalfa is blown up into a second collector shown in the background, and put into bags. Two Waukesha motors furnish the power. A 55-hp engine operates the rotating drum, suction fan, compressor for supplying air to the oil burner nozzles, and for the feed conveyor. The 100-hp engine operates the hammer mill.

While the process of drying certain agricultural products is not at all new, it was not until comparatively recent years that experimental dryers were built in this country, the scope of the field enlarged, the need of fundamental investigations realized, and the manufacture of commercial units begun. The artificial drying or dehydration of agricultural products is essentially an economic measure, and if sufficiently low-cost methods of drying can be developed, it would seem that they may have a profound influence on the agriculture of this country. There are many areas advantageously located in low freight rate zones where large crop yields are possible, but where climatic conditions are such that certain crops cannot be cured with reasonable certainty after they are grown.

The success of such a plant pictured here will be watched by agricultural engineers with a great deal of interest.



# The More Recent Trends in Engineering Education and Research[1]

By A. A. Potter[2]

THE GROWTH in the density of the population of the U.S.A. has gone on simultaneously with a more general appreciation of education. It has always been our American faith that an educated electorate is the cornerstone of a successful democracy. While during recent months, in the hysteria of drives for lower taxes and government economy, the educational system of this country has received a severe setback, the faith of our people in education is still undimmed. The average American is anxious to afford the youth of our country such educational advantages as will enable them to discharge most effectively their obligations as citizens.

There is a greater realization at present than ever before that the mental and moral discipline formerly belonging to the home has to be supplied by formal education. In days past when our wants were few, when the necessities of life were supplied by hand labor, when the home was the educational center as well as the social and industrial center, the independence of the individual made his education of no concern to the public. The interdependence of modern life and the difficulty of keeping our social organization and our economic structure properly balanced makes the future of our country greatly dependent upon the type of education our youth is receiving.

Only those who have no conception of the place of education in a democracy are willing to sacrifice the future of our youth in order to cover up extravagances in certain of our governmental activities. If the world of tomorrow is to be an improvement of that in which we are living, it is up to all of us not to disregard the education of youth by false economies and by the neglect of our teachers who are shaping the careers of the citizens of tomorrow. The education of our youth cannot be postponed or decreased in effectiveness without paying great penalties in the days to come. Education represents our hope in the future, is our chief bulwark against the destructive forces of extreme radicalism, and has as its main objective the promotion of well-being and the highest qualities of life.

## ENGINEERING AND ENGINEERING COLLEGES

The engineer of today touches the life of every individual in an industrial nation, and our economic order is dependent upon him to organize human effort, so that the forces and energies of nature are utilized most effectively in the service of mankind. The engineer is assuming a most important role in the lives of civilized people, and it is expected that his activities should definitely improve our social order. Accordingly, the preparation of the engineer is of general concern, as his work affects human happiness.

The improvement in our standards of living has gone on simultaneously with a more general appreciation of scientific and engineering education. Arthur James Todd, in the preface to his "Theories of Social Progress," stated: "If humanity is to hold the threads of its own destiny and rise from ages of blind drift to a place of mastery, it will be through the discovering and utilizing of new types of education.

Engineering education, other than military, a newcomer in professional education, was started in this country at the Rensselaer Polytechnic Institute in 1824 and by 1862 five additional engineering colleges were added. The Morrill Land-Grant Act, signed by President Lincoln in 1862, provided means for rapid extension of engineering education and made this type of education widely accessible to the industrial classes. From 1862 to 1880 the number of engineering colleges increased from 6 to 85, and by 1929 to over 150 with an enrollment of about 60,000 engineering students.

Engineering was the first profession to organize a society devoted to the improvement of collegiate teaching, the Society for the Promotion of Engineering Education having been started in 1893. The rapid growth in the number and in the enrollment of the engineering colleges of this country during the past seventy years is an indication that there has been public approval of the type of education offered by these institutions. To an increasing extent, industries, utilities, and public works are dependent upon graduates from engineering colleges not only for the solution of their technical and scientific problems, but also for executive and administrative posts.

The development of the engineering college in type and in effectiveness was not the result of active interest on the part of engineers, but has followed closely the progress of science, industry, and the engineering profession. In a sense, it was brought about as a result of the recognition on the part of the public of the importance of applied science.

With the increasing complexity of modern industry and its constantly growing dependence upon technological improvement and new leadership, it is bound to have an increasingly direct interest in the product of engineering colleges. Engineering educators are dependent upon industry to keep their instruction abreast of the times and their research activities most effective.

## PRESENT ENGINEERING CURRICULA

The interest of engineering colleges has, until very recently, centered in undergraduate instruction. Some of the weaker of these institutions stressed vocational and practical training, but the better engineering colleges realized the difference between training and education, and stressed the development of the student's reasoning power without regard to his immediate usefulness after graduation. No effort was made by the best of these colleges to turn out a finished product, but to prepare their graduates for the largest ultimate development and for the greatest usefulness in the long run. The program of studies is made up so that the student devotes about half of his time to science, mathematics, and the so-called humanities, and about an equal amount of time to technology.

Until very recently the great demand for engineering college graduates with bachelor's degrees and inadequate recognition on the part of industry and the engineering profession of resident graduate study have been responsible for the small number of engineers who held advanced academic degrees. Graduate study has received a new impetus in connection with the development of engineering research at institutions of higher learning and was also stimulated by the realization of some industries that advanced scientific knowledge is a necessity for their future development. Growth in engineering graduate courses has been particularly noticeable since 1930, as engineers out of employment are striving to improve their preparation in order to be ready for greater responsibilities when industrial conditions improve.

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[1]Paper presented at the 27th annual meeting of the American Society of Agricultural Engineers, Purdue University, June 1933.

[2]Dean of engineering, Purdue University. President, American Society of Mechanical Engineers.

A group of nearly twenty, consisting of agricultural engineering staff members and agricultural engineering students of Oregon State College, attended the 27th A.S.A.E. annual meeting in June. This picture shows the group and their bus on the Oregon State campus shortly before the start of their trip which totaled nearly 6,000 miles of travel

Most of the undergraduate and graduate curriculum lead to degrees in architectural, chemical, civil, electrical, mechanical, and mining engineering. In some institutions specialized undergraduate curricula are offered in aeronautical, agricultural, building, ceramic, highway, railway, and other specialized branches of engineering. Several institutions also offer special undergraduate curricula in industrial or administrative engineering. About ten per cent of the total engineering students of this country are pursuing cooperative engineering courses which combine practical experience with scholastic training; there seems to be no difference in the results secured with cooperative and all-resident curricula. Nearly two-thirds of all engineering students are pursuing curricula which lead to degrees in civil, electrical, and mechanical engineering, and the enrollment in chemical engineering during recent years has been increasing very rapidly.

## RESEARCH, INVENTION AND DEVELOPMENT

Research is a fact-finding agency. It has as its aim the orderly search for something hitherto unknown by the employment of the scientific method. Mr. Charles F. Kettering calls research "a state of mind" which "tries to find out whether those things we think are so, really are so, which is the difference between facts and opinions." Engineering research has as its special objective the development by scientific means of new manufactured products, more efficient machines and tools, special mechanisms, improved devices, reliable meters and instruments, better manufacturing processes, and more economical methods of operating equipment.

No very clear line can be drawn between pure scientific and engineering research, although the latter is more generally concerned with results of immediate economic value. Development is usually the product of research, or may follow it if a successful product is the aim. Laboratories of research and development are now taking the place of chance discoveries by inventors.

Although this country has less than one-twentieth of the population of the world, our inventors are responsible for more than two thirds of the epoch-making inventions which we enjoy. The telephone, the telegraph, the electric light, the motion picture, the talking machine, the sewing machine, the typewriter, the aeroplane, and, in fact, most of the wonders of our times are the results of American inventive genius. One reason for this is that this country has attracted and developed the most adventurous and the most creative people of all nations. Furthermore, the incandescent light, the automobile, steel manufacture, and electric communication have been developed through research.

While society owes much to inventors, modern industry cannot wait upon the chance discoveries of men of genius. Research laboratories must be used to acquire new and exact knowledge of facts, to develop new products, improved machines, and methods which will lower manufacturing costs.

## RESEARCH AGENCIES

Engineering research in the United States of America is carried on in industrial laboratories, by commercial testing organizations, by engineering societies, in special research institutes, by government bureaus and departments, and by the engineering colleges.

Several of the national engineering societies are carrying on research through standing committees. Foremost among these is the American Society of Mechanical Engineers, which has expended from its own funds since 1921 about $100,000 in organization, development, and other research activities, and the success of its efforts is attested by the fact that during the same period American industry has contributed over $320,000 for investigations under the direction of the A.S.M.E. Even during the difficult year ending September 30, 1932, the receipts from industry and from other sources for research directed by the A.S.M.E. was over $40,000.

## RESEARCH IN THE COLLEGES

The research specialist in the engineering college is working in an atmosphere which is sympathetic to research, he is more free from interruptions, and his work reacts beneficially in improving the main product of educational institutions—the students who are being trained and educated for the profession of engineering.

Research in engineering colleges may be carried on either in organized research departments, usually called engineering experiment stations, or by individual teachers.

Over forty state-supported engineering colleges of the U.S.A. have organized research departments. These organized experiment stations have published during the past twenty years over 850 bulletins. All engineering colleges are encouraging research either on an organized basis or by individual teachers.

The supplement to the "Journal of Engineering Education" published in February, 1931, records the status of engineering research in the colleges and universities of North America. Leaving out the Mellon Institute of Industrial Research, the engineering colleges of the U.S.A. received $1,225,570 for research during 1928-29 from outside sources; $668,853 from institutional funds, and $262,440 by legislative appropriation. This made a total for the year 1928-29 of $2,156,863 and provided for the employment of 575 full-time and 807 part-time research workers.

While two-thirds of American engineering colleges

claim to be conducting some investigations, not more than ten are making definite contributions to engineering knowledge through cooperative research. The most outstanding of these are the University of Illinois, Iowa State College, Massachusetts Institute of Technology, Cornell University, University of Michigan, Ohio State University, and Purdue University.

The University of Illinois has been active in cooperative engineering research for over a quarter of a century, and the results of its contributions are recorded in 250 bulletins of its engineering experiment station and in numerous papers before engineering societies. The major investigations of the University of Illinois are concerned with fuels, materials of construction, fatigue of metals, feed water, and household heating.

The contributions of the Iowa Engineering Experiment Station have also extended since 1904 and are recorded in over 100 bulletins with major emphasis upon Iowa problems and upon culvert pipe.

The Massachusetts Institute of Technology and Cornell University have also been pioneers in engineering research and their early contributions to technical knowledge cover a wide field. More recently the Massachusetts Institute of Technology has been giving major emphasis to the theoretical and purely scientific problems.

The University of Michigan has been most outstanding in cooperative research with engineering societies, industries, and utilities.

Ohio State University has been a leader in fuel and in ceramic research and with particular reference to the betterment and gasification properties of Ohio coals. Its contributions include nearly 100 bulletins.

Cooperative research at Purdue University was started in the early eighteen nineties by the late Dean W. F. M. Goss, who installed the first test locomotive in the world and who greatly aided the railroads in standardizing and improving their mechanical equipment. Cooperation between Purdue University and the American railroads has continued since that time and has involved a great variety of investigations on brake shoes, superheaters, air brakes, locomotives, car wheels, car couplers, draft gears, front ends, etc.

In order to illustrate the types of investigations carried on by engineering colleges, a few of the more recent investigations in the Purdue engineering laboratories will be described.

Studies of power airbrakes in cooperation with and at an expense to the American Railway Association of over one million dollars has resulted in greater safety to the public and in enormous savings to the railroads of North America. Investigations of draft gears in cooperation with the American Railway Association, and at an expense to this Association of over $100,000, has resulted in definite specifications and improved designs of draft gears (shock absorbers) for railway cars. Other investigations now under way in cooperation with the American Railway Association include automatic train connectors (steam and air lines) and tank car accessories.

## KNOWLEDGE OF VALUE TO INDUSTRY

Fundamental knowledge of value to the manufacturers and users of motor vehicles has been supplied through studies of carburetors, pistons, steering gears, lubricating oils, spark plugs, automobile performance, and tractor and truck tests (for manufacturers and the federal government). In cooperation with the Society of Automotive Engineers and with the electric railways, the riding qualities of motor vehicles have been investigated from the psychological and physiological as well as from the engineering standpoints.

Conversion and specially designed gas heaters for household use have been investigated in cooperation with the Indiana Gas Association which has contributed $56,000 for the six years ending September, 1933. Welding with manufactured gas, natural gas, and mixed gases has resulted in new designs of gas torches and in extending the field of use for gas. This problem has been investigated at the expense of the Utilities Research Commission of Chicago.

For seven years the Indiana limestone interests have supported research which has resulted in methods for preventing and removing discoloration in limestone. Purdue University has been a pioneer in concrete research and recent investigations in this field have been of particular value to the road building program of the state and nation. These studies were concerned with improving the durability of concrete, better designs for road slabs, more effective mixtures and better test methods. The engineering researches of Purdue University have also contributed to the development of a new building material, which is being manufactured from wastes, and which gives promise of extensive application.

Purdue University was one of the first institutions to undertake studies with voltages above one-half million volts. These have resulted in great benefit to the manufacturers of insulators and machines, as well as to high-voltage transmission. By-products of these studies are the cathode-ray oscillograph mentioned before and new methods for manufacturing nitrogen and ozone.

The Utilities Research Commission of Chicago has cooperated with Purdue University in several projects of distinct value to electric power transmission, the most important of which are the perfection of special wire insulations and protection from lightning.

The results secured by industry through cooperative investigations at engineering colleges indicate that such institutions can undertake and carry out successfully research projects of any magnitude. Engineering societies, trade associations, public utilities, and industries (both small and large) will find that money invested in research, at carefully selected engineering colleges, will pay large dividends not only in practical results secured but also in increasing the supply of engineers and scientists who have the training to extend the frontiers of useful knowledge.

And there is need for more research in engineering as related to agriculture.

## PROBLEMS BEFORE ENGINEERING COLLEGES

The activities of the engineering profession in connection with the present period of readjustment has resulted in a general belief that the present economic unbalance can only be corrected by the engineer. The engineer, who has contributed greatly to the improvement of the material welfare of humanity is expected to bring about a better economic order and to take a most active part in the solution of the problems which affect the civilization of his creation. During these changing conditions the engineer of tomorrow must be prepared not only to take his place among the best educated leaders of other professions, but must be ready to assume great economic and social burdens in order to aid in bringing about permanency for our civilization.

The engineering colleges have a great responsibility to meet the demands of our times so that their graduates will not only be capable as engineers, but professional people who are familiar with the trends in human progress and who will be able to take an active and leading part in building a rational world.

There has been a tendency on the part of engineering educators to magnify the differences in civil, electrical, mechanical, and other branches of the engineering profession. As early as 1893 the president of the American Society of Mechanical Engineers, E. B. Coxe, in his annual address stated that "the position which the successful engineer occupies does not depend upon whether he graduated as a C.E., E.E., M.E., etc., but upon the fact that he has a mind and has had a training which has enabled him to develop in a particular direction." It should also be recognized that the work of the engineer in practice is organized largely along functional lines of research, design,

production, operation, and sales rather than in the fields of demarcation followed by our engineering societies. There is a rather general opinion that the engineer of today is well grounded in his special field, but has little knowledge of other branches of engineering, and is absolutely ignorant of social implications and economic trends.

To meet increased competition for positions of responsibility our graduates of the future will have to be more thoroughly prepared in the fundamental sciences, will have to be able to express themselves more clearly and correctly, and will be expected to have a better appreciation of economic forces and social values.

While there may be no need for a complete readjustment of engineering education, college faculties will do well to analyze their curricula with major consideration to the student and to the increased competition which he is bound to meet in the future. Engineering undergraduate curricula should be simplified by reducing to a minimum descriptive, vocational, and specialized courses which have as their main purpose not the development of intellectual capacities but the training for a job. We must realize that the main objective of engineering education is the preparation for successful living in our scientific age. At the same time the basic instruction in mathematics, science, English, economics, and technology should be more thorough, and the graduates should show a greater interest in aesthetic and intellectual matters.

### COOPERATION WITH THE ENGINEERING PROFESSION

During these changing conditions our profession realizes that the engineer of today must not only be able to take his place among the best educated of other professions, but he must be ready to assume great social and economic burdens in order to aid in insuring the permanency of our civilization. Thus the engineering societies are interesting themselves to a greater extent than ever before in the preparation of the engineer. In the past the engineering profession, as such, has not taken a very active part in shaping or in directing engineering education. The aid given up to date to engineering colleges has been informal, has not represented well-developed, concerted action, and has generally impressed the governing bodies of colleges and universities as having little, if any, of the weight of the profession back of it.

During the past year steps have been taken which it is hoped will result in enhancing the professional status of the engineer. I am referring to the Engineers' Council for Professional Development, which is an outgrowth of the study of the "economic status of the engineer" which was made during 1931 by a committee of the A.S.M.E. headed by Conrad N. Lauer. In his report, Mr. Lauer stated that his committee has come to the realization that, if the economic status of the profession is to be improved, the professional and social status must be improved as well. The profession itself must establish standards for selecting engineering students, must cooperate in their formal education, must take an important interest in their post-college training, and must provide a suitable goal of achievement.

As a result of the recommendations of Mr. Lauer's committee, the A.S.M.E. has joined with the other major engineering societies in a movement designated as the Engineers' Council for Professional Development, which has placed itself four objectives:

1. Insure that only properly qualified young people seek admission to engineering colleges.
2. Bring about effective cooperation between the engineering profession and engineering education.
3. Aid the young engineer in developing to full professional status by post-scholastic education and by professional contacts.
4. Insure proper recognition for the engineer who has attained full professional status.

The above program is definitely focused upon the educational preparation of the engineer, from the period before his entrance to college through his early years in practice and until he is ready to receive professional status. It is hoped that this will result in insuring higher professional recognition for the engineer.

No progressive American believes that the last frontier has been reached or that America has passed its zenith of greatness. The tremendous natural resources of this country, the creative and inventive talent of our people, our gift of utilizing science and machinery, and the good sense of the average American not to be carried away by false doctrines will all combine in bringing back, before long, better and more prosperous times than ever before. It is only by the active cooperation of the profession and of the engineering colleges that the engineer of tomorrow will be best prepared to contribute his talents in bringing about a more general well-being than the world has ever known before.

## A Pneumatic-Tire-Equipped Mower

THE accompanying picture shows a mower provided with balloon-type, rubber-tired wheels, especially thus equipped for mowing shoulders along hard-surfaced highways. But, in addition to use along highways, this pneumatic-tired mower is specially suited for use in fields where special crops or adverse conditions make the use of ordinary mower wheels equipped with lugs not as satisfactory. For highway use, the pneumatic tires provide greater traction and make riding easier than the old-style, hard-rubber tires formerly used on highway mowers.

The balloon tires are the 5.25x21 size, fit over conventional automobile-type rims, and are secured by locking lugs attached to each spoke. This makes removal of the tires as simple as on an automobile. Each wheel is provided with a special split hub, which makes it easy to slip the wheel on to the axle shaft. After being put in place, the wheel is clamped tightly around the axle by four bolts through the hub. The wheel is also keyed to the axle.

The main axle, to which the wheels are solidly keyed, is made in two sections, and these are connected by a differential arrangement inside the gear box. With the wheels keyed directly to the axle, end play and wabbling are eliminated.

And think of the personal comfort to the operator who rides this mower!

And now a mower equipped with pneumatic rubber tires

# Comparative Test Results of Rubber Tires and Steel Wheels for Tractors[1]

By Lloyd W. Hurlbut[2]

THE comparative test of steel wheels and low-pressure rubber tires for tractors reported herein was made at the University of Nebraska during the past school year. The aim in this work was to secure fundamental information regarding comparative performance of steel wheels and rubber tires for tractors over their working range. This information secured was from (1) tests on the tractor testing track, and (2) observations. During the school year it was impossible to make extensive tests under field conditions.

The first data presented in this report are taken from the tractor-testing track. The equipment used consisted of

An Allis-Chalmers Model "U" tractor
One pair of steel wheels with spade lugs for the rear
One pair of steel wheels with skid rings for the front
One set of Firestone low-pressure rubber tires and tubes
One Gulley hydraulic dynamometer
One instrument car
One McCormick-Deering tractor equipped with a centrifugal pump for drawbar loading
One 500-cc burette for measuring fuel consumption
One mercury manometer used to find the engine horsepower
One 150-hp electric dynamometer.

In fact, all special equipment about the tractor-testing laboratory was available and used as needed.

The static weights of the tractor, when equipped with rubber tires and wheel weights, 425 lb on each drivewheel, plus the driver, were 1570 lb front and 3430 lb rear—total, 5000 lb. When equipped with steel wheels and lugs plus the driver, the weights were 1650 lb front and 2895 lb rear —total, 4545 lb.

A mercury manometer was constructed to use in getting the engine horsepower, or the horsepower input to the wheels, in the field. A copper tube was used for the connection between the manometer and a point 2½ in above the throttle valve on the riser of the intake manifold. The vacuum in the intake manifold varies with the speed, throttle opening, and load. The manometer was calibrated by getting the horsepower delivered by the tractor to an electric dynamometer, and the difference in mercury levels of the manometer. Our aim was to keep the cooling water at approximately 180 deg F. Constant speed curves were plotted, using the differences in mercury levels in the manometer as ordinates and the brake horsepower, corrected to standard conditions, as the abscissas. With the engine speed and the mercury difference known, the engine horsepower in the field was determined from the graph.

Fuel for the tractor was supplied from the regular tank for deadheading and warming up, and from a 500-cc burette over the measured course. Fuel readings at the beginning and end of the course were taken while the tractor was not in motion.

The revolutions of the drivewheels were taken by specially constructed electrical counters.

The engine governor was locked into position and left to handle the different loads throughout the test.

The effective circumference of the drivewheels on the track at the time of the test and at no drawbar load, was 11.27 ft with rubber tires, and 13.29 ft with steel wheels and lugs. The steel wheels used on the rear were 42 in in diameter and 11⅛ in wide, each being equipped with twenty 5-in spade lugs. The front wheels were the 28-by-4-in plain band type. The lug points were quite blunt so they did not penetrate to their full depth. The rubber equipment consisted of 11.25-24 pneumatic tires on the rear and 6.50-16 in front. The rear tires were inflated to 12 lb and the front tires to 15 lb.

The track soil is Waukesha silt loam. It was dry and hard with about ½ in of loose mealy surface. During September it was graded and smoothed. This test was completed during the last three days of February under as nearly identical conditions as we could expect to obtain. The rubber tires were tested first, and the test of the steel wheels followed.

The method of conducting the tests was as follows: Four points, determined by different loads, were taken for each gear. Each point represents a travel of 2000 ft. For each point four readings were taken. Each reading represents a travel of 500 ft.

A course of 500 ft was measured off on each side of a rectangular-shaped track. At each end of the course two poles were set at right angles to the line of travel. These served as limits to the course over which measurements were taken. A straight length of track at the ends allowed the tractor to come to normal operation before entering the measured course.

## SUMMARY OF TEST RESULTS

The following is a summary of results of the test on the tractor testing track:

1. For any given engine horsepower a greater drawbar horsepower was obtained with rubber tires than with steel wheels and lugs.

2. With rubber tires the maximum drawbar pulls in low, second, and high gear are nearly the same.

3. Steel wheels and lugs had the advantage in both drawbar pull and speed in low and second gear. In high gear, steel had the advantage in speed up to a drawbar pull of 1250 lb. Rubber tires had a considerable advantage in drawbar pull with a maximum pull of 2190 lb in high gear.

4. The maximum drawbar pull for rubber tires was 2230 lb in second gear. For steel wheels and lugs it was 3200 lb in low gear.

5. The rubber equipment showed the better fuel economy based on drawbar horsepower. High gear with rubber showed the maximum fuel economy.

6. The maximum drawbar horsepower developed with rubber tires was in high gear. The maximum with steel wheels was in low gear.

7. The direction to best fuel economy with rubber tires is higher speeds with the drawbar pull remaining nearly constant. The most efficient drawbar load in this test was near 1800 lb.

## SUMMARY OF FIELD OBSERVATIONS

1. The traction in mud of a tractor equipped with rubber tires, without chains, is similar to that of an automobile or truck.

2. Rubber tires equipped with lug-type chains will pull as much as the steel wheels and lugs on dry soil, and more in muddy conditions. A creeping, oscillating movement of the lug-type chain keeps them clean in soil conditions that fill up the steel wheel with fixed lugs. This

[1]Report presented at a session of the Power and Machinery Division of the American Society of Agricultural Engineers during the 27th annual meeting of the Society held at Purdue University, June 1933.

[2]Graduate student in agricultural engineering, University of Nebraska.

test was carried out on an area covered with alternate patches of snow and mud. The mud varied from slick and slushy to the sticky mud that fills up the fixed lugs.

3. An unmeasured but comparative test was made between rubber tires and steel wheels with a Killefer subsoiler. The field had been plowed several weeks before, but a good rain had settled the ground noticeably. The soil was dry on top but moist underneath. It was dry enough to permit such field operations as disking, harrowing, or the like. The tractor, with rubber equipment, pulled the Killefer at a greater depth in second gear than the steel wheels did in second or low gear. Steel wheels and lugs milled the soil considerably, and then finally dug down. The rubber tires proved to have good traction, but showed a tendency to pack the soil. We have no comparative bases for measuring this packing effect.

4. A short test was made with a 14-inch, two-bottom plow in sudan grass sod. The tractor, with rubber equipment, handled the plow with ease in high gear.

5. It was quite obvious that the tractor, when equipped with rubber tires, was relieved of the severe jarring impacts. This should give the tractor a longer life.

6. The tractor, with rubber equipment, was much more comfortable to ride on the tractor testing track. Considerable bouncing was experienced when passing over rough ground.

7. The greatest task in wheel changing was the placing of the weights on the rubber-tired wheels. This was much reduced, however, by the use of a piece of 4-in gas pipe slipped through the weight opening and over the hub nut. This helped to lift the weight and hold it in place while it was being clamped on the wheel.

More tests under different field conditions and operations need to be made to find the real comparative value of rubber tires and steel wheels. We are already working on an extensive field program that is to be carried out this summer.

(AUTHOR'S NOTE: The author gladly shares credit for this work with Eliseo K. Ougsansoy and C. W. Smith. He also wishes to acknowledge the fine cooperation of the Allis-Chalmers Mfg. Co., Firestore Tire & Rubber Co., the Goodyear Tire & Rubber Co., and Chain Products Co.)

# Control of Stem Rot of Rice by Burning Stubble[1]

By E. C. Tullis[2], J. B. Woods[3] and Dean G. Carter[4]

STEM rot is one of the destructive diseases of rice in the Southern States. It is caused by the fungus Sclerotium oryzae Catt. S. oryzae rots the rice culms and forms in them abundant resting bodies called sclerotia, which overwinter in rice stubble, straw, and the surface layer of the soil, and infect the rice crop the following year. (Fig. 1). The experiments reported in this paper were undertaken to determine whether these sclerotia might be destroyed by burning stubble, straw, and weeds on rice fields.

The work on which this report is based was conducted cooperatively from 1930 to 1932 by the Division of Cereal Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture, and the departments of Plant Pathology and Agricultural Engineering of the Arkansas Agricultural Experiment Station. In 1931 the Buerau of Agricultural Engineering of the U. S. Department of Agriculture also cooperated in the experiments by furnishing a tractor-drawn burner of the type used experimentally in the investigations for controlling the European corn borer and aphids on alfalfa in California[5].

The first experiments were conducted in 1930 on a field badly infested with stem rot near Stuttgart, Arkansas. A hand burner was used. The treatments and the results are given in Table I. The percentage of plants showing stem rot is based on an examination of 150 plants from each plot. This percentage in each case is the average for the following varieties: Fortuna, Blue Rose, and Caloro.

In 1931 the field burner furnished by the Bureau of Agricultural Engineering was used on field plots. The machine was tractor-operated and included fuel tank, oil pump, compressor, and accessory equipment, together with

[1]Research Paper No. 306, Journal Series, University of Arkansas. Released for first publication in AGRICULTURAL ENGINEERING.

[2]Agent, division of cereal crops and diseases, Bureau of Plant Industry, U. S. Department of Agriculture.

[3]Assistant agricultural engineer, Arkansas Agricultural Experiment Station. Jun. A.S.A.E.

[4]Agricultural engineer, Arkansas Agricultural Experiment Station. Mem. A.S.A.E.

[5]The Burner was operated by Orve K. Heddeb, assistant agricultural engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture.

**Table I. Percentage of Rice Plants Infected with Stem Rot Following Various Burning Treatments, 1930**

| Plot number | Treatment | Stem-rotted culms (Avg. of three varieties) Per cent |
|---|---|---|
| 1 | Burned | 14.3 |
| 2 | Burned, plowed, burned | 33.0 |
| 3 | Straw-burned | 14.6 |
| Checks | None | 42.7 |

**Table II. Percentage Germination of Sclerotia of Sclerotium Oryzae from Field No. 1**

| Sclerotia from | Treatment | Sclerotia | | |
|---|---|---|---|---|
| | | Number tested | Number germinated | Percentage germinated |
| Stubble | Burned once | 177 | 0 | 0 |
| do | do | 652 | 0 | 0 |
| do | Burned twice | 276 | 1 | T* |
| do | Not burned | 531 | 101 | 19 |
| Soil | Burned once | 50 | 2 | 4 |
| do | Burned twice | 142 | 1 | T* |
| do | Not burned | 55 | 11 | 20 |

*Trace, less than 1 per cent

**Table III. Percentage Germination of Sclerotia of Sclerotium Oryzae from Field No. 2**

| Sclerotia from | Treatment | Sclerotia | | |
|---|---|---|---|---|
| | | Number tested | Number germinated | Percentage germinated |
| Stubble | Burned once | 985 | 1 | T* |
| do | do | 1,106 | 21 | 1.9 |
| do | Burned twice | 899 | 1 | T* |
| do | Not burned | 1,169 | 76 | 6.4 |
| Soil | Burned once | 168 | 1 | 0.6 |
| do | do | 30 | 3 | 10.0 |
| do | Burned twice | 112 | 5 | 4.4 |
| do | Not burned | 92 | 3 | 3.0 |

*Trace, less than 1 per cent.

a gang of five low-pressure, air-atomizing oil burners, and a protecting hood. (Fig 2).

An intense heat is generated by the burner, and a large metal hood confines the heat and flame close to the ground in contact with the stubble, grass, and weeds. Because of intermittent rainfall, burning once over failed to completely consume these materials. Therefore, portions of the test fields were burned a second time.

Germination tests show that burning was effective in the destruction of sclerotia in the stubble and the surface inch of soil. The results are presented in Tables II and III.

Because of incomplete burning due to ground and stubble moisture and the crushing effect of the wheels of the tractor and burner, an attempt was made to ascertain whether the position of the stubble had an influence on the effectiveness of the burning. The results are shown in Table IV.

**Table IV. Percentage Germination of Sclerotia of Sclerotium Oryzae as Affected by Position of Stubble**

| Position of stubble | Sclerotia | | |
|---|---|---|---|
| | Number tested | Number germinated | Percentage germinated |
| Standing | 790 | 4 | T* |
| Lying on the soil | 899 | 50 | 5.5 |
| Crushed into the soil | 335 | 28 | 8.3 |

*Trace, less than 1 per cent.

In so far as the effect on infection and yield of the following crop was concerned, the reduction in the number of viable sclerotia as a result of burning was insufficient to effect a control, and the rice crop on the burned and unburned areas was uniformly diseased.

At the time these experiments were begun in 1930 it was thought that the sclerotia of Sclerotium oryzae were the only source of inoculum for infection of the subsequent rice crop. Further investigations of the fungus have demonstrated that, in addition to the sclerotia, the fungus produced a conidial stage, Helminthosporium sigmoideum Cav., and an ascigerous stage, Leptosphaeria salvinii Catt.[6,7] Both these spore forms, in addition to the sclerotia, have been found in the field and both of these spores also may produce infection. The conidia are produced in large numbers on the sheaths of infected plants, and the indications are that they are also produced by the sclerotia as they float on the surface of the water. Sclerotia in fragments of stubble or in the soil are potential sources of inoculum sufficient to infect a whole field.

To conclude the burning control phase of this study, the work was transferred in 1932 to plots on the Rice Branch Experiment Station at Stuttgart, Arkansas. Twelve plots and three methods of treatment were used. The latter consisted of burning the stubble and raking the seed in, burning and plowing, and burning, plowing, and reburning. One hundred plants from each treatment were examined at the end of the growing season to determine the extent of infection. The results are presented in Table V.

**Table V. Infection of Rice Plants with Sclerotia of Sclerotium Oryzae in Plots, 1932**

| Plot No. | Treatment | Percentage of plants infected |
|---|---|---|
| 1 | Burned, seed raked in | 60 |
| 2 | do | 77 |
| 3 | do | 93 |
| 4 | do | 80 |
| 5 | Burned, plowed | 86 |
| 6 | do | 75 |
| 7 | do | 90 |
| 8 | do | 91 |
| 9 | Burned, plowed, burned | 94 |
| 10 | do | 97 |
| 11 | do | 95 |
| 12 | do | 88 |

## CONCLUSIONS

1. In these experiments burning stubble and straw on the surface of the soil did not completely destroy all the sclerotia of the rice stem rot fungus in the soil.

2. Investigations have shown that the fungus produces conidial and ascigerous stages, which also may produce infection, and that conidia may be produced in abundance from the relatively few sclerotia not killed by the burning.

3. Burning the straw and stubble on fields kills numerous sclerotia, and therefore appears to be a desirable practice for the control of stem rot when used in conjunction with other recommended measures[8].

[6]Tullis, E. C. Helminthosporium sigmoideum, the conidial stage of Sclerotium oryzae. (Abs.) Phytopathology 22: 28. 1932.

[7]Tullis, E. C. Leptosphaeria salvinii, the ascigerous stage of Sclerotium oryzae. (Abs.) Phytopathology 23: 85. 1933.

[8]Tullis, E. C. Rice investigations. In Arkansas Agricultural Experiment Station, Ann. Rpt. 42 (Bul. 275): 72-73. 1930.

# A Correction

THE authors of the articles, entitled "Field Curing of Hay as Influenced by Plant Physiological Reactions," appearing on page 156 of the June 1933 AGRICULTURAL ENGINEERING call attention to an error occurring in Fig. 4. The key to the curves should have been reversed, that is, the broken line indicates the "Internodes," and the solid line "Stems with 3 nodes, leaves removed."

Fig. 1. (Left) Rice stubble infected with stem rot. Fig. 2. (Right) Tractor-drawn, oilatomizing burner designed by the Bureau of Agricultural Engineering, U. S. Department of Agriculture, and used in studies of the control of stem rot of rice

# Certain Technical Aspects of Motor Fuels[1]

By Jacque C. Morrell[2]

IT IS DIFFICULT to realize that the petroleum industry with a normal investment of approximately 11 billion dollars, and with a refining capacity in the United States of over one billion barrels of crude oil per year, maintaining approximately 100,000 miles of pipe line for its transportation, had its inception less than 75 years ago with the drilling of the first oil well at Titusville, Pennsylvania, and obtained its principal impetus less than 40 years ago with the advent of the first successful automobile in the United States in 1894.

While the automobile and the internal-combustion engine generally have stimulated the petroleum industry, resulting in its enormous growth and expansion, it is the cracking process for the conversion of heavier hydrocarbons into lighter hydrocarbons within the gasoline boiling range which has allowed the petroleum industry to meet the demands of the automotive industry for a relatively cheap motor fuel. The cracking process has resulted in a saving of almost one-half billion barrels of crude oil a year to meet the demand for gasoline. The present investment in cracking equipment is approximately 400 million dollars, and about 50 million dollars were spent in the development of the process. However, as a result of this development there has been a conservation of more than 5 billion barrels of crude oil by increasing the yields of gasoline from oils containing relatively small percentages of it, and by cracking heavy oils containing practically no gasoline and obtaining over 50 per cent of motor fuel. During 1932 approximately 7 billion gallons of cracked gasoline were produced having a retail market value of approximately 700 million dollars.

The cracking process has not only resulted in increasing the yield of gasoline from crude oils and heavy oils obtained therefrom, but the anti-knock quality of the gasoline produced thereby has also been remarkably improved.

While there has been no shortage of petroleum, the very nature of its production brings up the question as to what resources are available for the manufacture of motor fuel if the supply of crude oil should fail. While it has been difficult to make estimates and predictions based upon them during the past several years, on the basis of approximately 30 million automotive engines now in existence, requiring approximately 13 billion gallons of gasoline per year, it has been estimated that approximately 20 billion gallons of gasoline will be required by 1950.

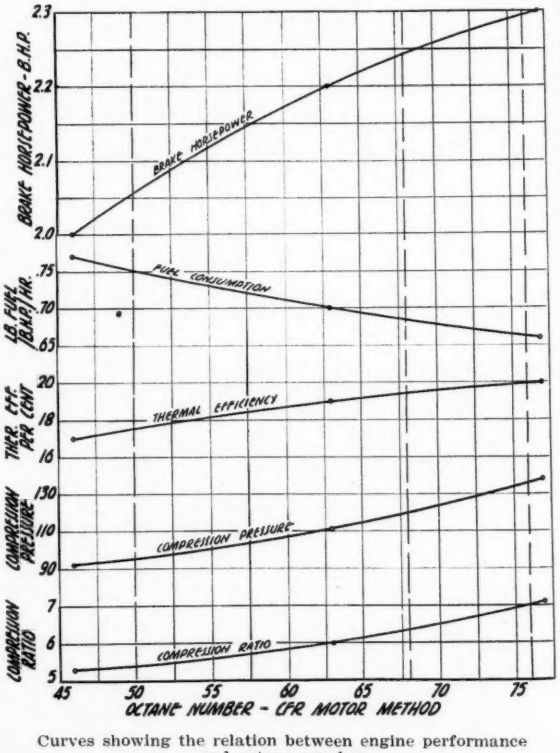
One consideration for the future is the release of heavy liquid and solid fuels for other uses by the introduction of hydro-electric power, and perhaps solar energy, and the conversion of these fuels into motor fuel by methods already established.

There are available in the United States alone over 3,000 billion tons of bituminous coal, including the semi- and sub-bituminous varieties. These coals will yield, by low-temperature distillation, an average of 25 gallons of tar per ton of coal, which can be converted by the cracking process into approximately 25 per cent motor fuel of high anti-knock properties. From this one source alone it is estimated that sufficient motor fuel can be recovered to supply the world for the next 800 years. The process for the direct conversion of coal (or heavy hydrocarbon residues) into liquid hydrocarbons by the use of hydrogen under high pressures of the order of 200 atmospheres, employing subsequent cracking of the hydrocarbons so obtained when desired, also offers a solution of the problem of converting coal into motor fuel.

The Fischer-Tropsch process for the catalytic conversion of carbon monoxide and hydrogen (which may be obtained by the water gas reaction from coal, or the coke produced therefrom) produces motor fuels either of the mixed alcohol (synthol) or hydrocarbon type, depending upon the catalyst and conditions of conversion employed. Approximately 40 per cent of motor fuel, based upon the weight of coke employed, may be obtained. If this method were used on all the bituminous coal available in the United States and upon the basis of present consumption, the supply of motor fuel would cover a period of about 12,000 years.

One may estimate further that the 400 billion tons of oil shale in the United States may be converted into over 180 billion barrels of gasoline by cracking, sufficient to supply the world's needs for motor fuel for over 150 years. The oils and tars from wood, peat, lignite, and the like, and even animal and vegetable oils such as those from cottonseed, palm, fish, seal, etc., produce high yields of gasoline when cracked. This presents the curious possibility of actually producing gasoline by methods analogous to those employed in the domain of agriculture.

The use of any of the methods for production of motor fuel described above is mainly a matter of economics. Practically all of the technical problems involved have already been solved. Of course, there are products which are available immediately, such as grain alcohol and benzol, but based upon present production these represent only a minor percentage of the quantity of motor fuel consumed. For example, the production of 50 million gallons of alcohol per year, if used solely as a motor fuel, would run the motor cars of this country for approximately




Curves showing the relation between engine performance and octane number

[1]Paper presented at a session of the Power and Machinery Division of the American Society of Agricultural Engineers during the 27th annual meeting of the Society held at Purdue University, June 1933.

[2]Associate director of research, Universal Oil Products Co.

one day only, and the production of benzol is less than 2 per cent of the motor fuel consumed in the United States, although a large percentage of the benzol production is blended with gasoline. It has recently been proposed to legislate the use of alcohol in motor fuels, and this question will be discussed further.

No doubt there will be considerable development in the direct utilization of heavy oils, tars, e.g., in Diesel engines, and even solid fuels for internal-combustion engines which of course is another angle of the problem.

* * * *

Owing to its great importance in the production of motor fuel the results obtained by the cracking process will be shown in some detail.

The following table is interesting in showing increase in the production of cracked gasoline based upon the total production:

**Percentage Yields of Straight-Run vs. Cracked Gasoline**

| Year | Total gasoline (per cent yield from crude oil) | Cracked gasoline (per cent of total gasoline) | Straight-run gasoline (per cent of total gasoline) |
|---|---|---|---|
| 1920 | 26.8 | 12.9 | 87.1 |
| 1930 | 38.0 | 38.0 | 62.0 |
| 1933 (Jan.-Feb.) | 44.5 | 53.3 | 46.7 |

In general, the cracking process comprises subjecting hydrocarbon oil to heat and pressure treatment in a heating coil, after which it is discharged into a reaction chamber and the vapors separated from non-vaporized residue comprising heavy hydrocarbon liquid. The process may also be conducted to produce a solid coke residue. The vapors are fractionated and the lower boiling hydrocarbons comprising gasoline condensed and recovered, the intermediate product of the fractionation being further subjected to cracking. The heavy liquid hydrocarbon residue and coke may be employed as fuel.

In addition to the production of gasoline as a major product, the cracking process also produces furnace oils, fuel oils, cracked gases which are suitable as fuel (or which may be employed for making chemical derivatives), asphalts, and coke. For example, last year the coke produced by the cracking process replaced approximately one million tons of bituminous and anthracite coal.

Yields of gasoline as high as 70 per cent and over have been obtained in the cracking of Pennsylvania and California gas oils, and over 60 per cent from some fuel oils.

Gasolines and naphthas with anti-knock values in octane numbers varying from 35 to 50 have been increased to from 70 to 80 by cracking. This is quite an important development for the treatment and improvement of poor straight-run gasolines.

The anti-knock value of gasoline is one of its important properties. Aside from objections to knocking per se, it is generally known that it reduces the power output and increases fuel consumption. The higher the compression pressure or compression ratio of a motor, the more efficient it is in power output, but, on the other hand, a given fuel has a greater tendency to knock with an increase in pressure. Hence, improvement in knock rating will permit operation of higher compression motors with a corresponding increase in efficiency. The use of an anti-knock motor fuel also permits hill-climbing without gear-shifting and eliminates knocking during acceleration.

The accompanying graph shows the relationship between octane number by the C.F.R. motor method and engine performance as measured by thermal efficiency, fuel consumption, and brake horsepower. The compression pressures and compression ratios were determined at maximum power output. It may be seen that the thermal efficiency in brake horsepower increases with an increase in octane number, with a corresponding decrease in fuel consumption. There is, however, a limit to which an increase in octane number is useful.

The anti-knock value of gasoline may be improved by cracking or increasing the percentage of cracked gasoline in the blend or by the addition of special compounds.

The volatility of a motor fuel is perhaps one of its most important characteristics. This is determined by vapor pressure and boiling point specifications. Inasmuch as volatility requirements will vary depending upon the season, the specifications are directed to cover these variations. For example, the vapor pressure during the months of June, July, August, and September should not exceed 8 lb as determined in a specific apparatus, and during the months of January, February, and March should not be less than 12 lb. An average of 10 lb vapor pressure is required when the temperature is above 27 deg F and when not in conflict with the above specifications.

In regard to the boiling range during the winter months, 10 per cent, including the distillation loss, should boil below 140 deg F and during the remainder of the year below 167 deg F. The other boiling point specifications are: 50 per cent at 284 deg F and 90 per cent at 392 deg F. No initial and end boiling points are specified.

The vapor pressure and boiling point ranges can be well controlled by cracking, and, in cases where naphthas are employed, blending with natural gasoline, that is, gasoline recovered from natural gas, or with stabilized gasoline from refinery gases, generally may be resorted to.

Cracked hydrocarbon oils containing the various hydrocarbon groups, namely, paraffin, olefins, aromatic and unsaturated hydrocarbons, in addition to sulphur, nitrogen, and oxygen derivatives of the same, involve refining problems chiefly to improve odor and color and to remove sulphur and gums or resin-like substances. In the refining of cracked distillates by chemical methods, sulphuric acid is the principal reagent employed, although chemical reagents, including other acids and heavy metal salts, have been used. Adsorbents which include the various earths, such as fuller's earth, have been employed for treating cracked hydrocarbons in liquid or vapor phase. Where the cracked gasoline contains high percentages of sulphur, large amounts of sulphuric acid must be employed, which causes losses by reaction and solution of various hydrocarbon groups present in the gasoline, principally unsaturated compounds, and also by polymerization of these compounds into higher boiling fractions than gasoline.

One of the principal developments in the refining of cracked motor fuels has been the use of inhibitors which prevent cracked gasolines from deteriorating in color, gum, and knock rating during storage. Inhibitors have been found to reduce the cost of refining agents and the loss of gasoline due to polymerization by sulphuric acid treatment. They also make unnecessary or substantially reduce the cost of treating plants. The deterioration of cracked gasoline is primarily an oxidation process caused by the gasoline contacting with air, and the function of an inhibitor is to prevent oxidation of the gasoline. The addition of an inhibitor to a cracked gasoline, whether treated or untreated, reduces the gum content of the gasoline by the copper dish test, even when the gum is initially very high. In many cases the addition of inhibitors to untreated gasolines impart to them a superior storage stability over refined gasolines. Unstable and untreated cracked gasolines, after addition of inhibitors, can be stored for long periods without formation of gum or with significant change in color or loss in octane rating. For example, the use of an inhibitor in a Pennsylvania cracked gasoline employing only 0.05 per cent reduced the copper dish gum from 259 to 19 mg—a lower figure than a treated sample. The inhibitor preserved the untreated gasoline for seven months without increase in gum and with a drop of only one point in octane number and very little color deterioration. During the same period the uninhibited refined sample showed a considerable

increase in gum and a loss in octane rating, while the untreated gasoline darkened in color, became very high in gum, and also lost octane rating. In many cases the use of an inhibitor has elminated acid treating and distillation operations and large savings have been brought about as a result.

Many different types of compounds have proved effective as inhibitors, e.g., among which are the polyhydroxy phenols, e.g., catechol and pyrogallol, naphthols, e.g., alpha naphthol and 1, 5 dihydroxynaphthalene, and amino phenols, e.g., ortho and para amino phenols, 2, amino, 5, hydroxytoluene, and many others which include many chemical individuals or mixtures in some cases unidentified.

In general, a gasoline which shows an induction period of approximately 4 hours by the oxygen bomb test (i.e., the time which elapses before there is an abrupt pressure drop in the oxygen bomb employed for testing due to absorption of the oxygen by the gasoline) is satisfactory for storage, and practically all untreated as well as many treated or refined cracked gasolines require an inhibitor for this purpose.

The increasing demand for high anti-knock gasoline has complicated the problem of stabilizing the product so produced, due to the higher temperatures and pressures required in the operations and other high percentages of gum-forming components present in the product. Gum inhibitors or anti-oxidants have solved the problem of preventing deterioration of these gasolines. These inhibitors are saving the oil industry at the rate of approximately 25 million dollars a year by eliminating the drastic refining necessary to remove the gum-forming hydrocarbons, and these savings will increase as the use of inhibitors are estimated.

It has recently been proposed to legislate the use of alcohol in motor fuels, and several bills were pending before Congress to compel the use of agricultural alcohol in gasoline by imposing a penalty on all gasoline not containing the right percentage of alcohol. The obvious purpose of this legislation is to relieve the farmer by removing a part of his products and converting it to liquid fuel, and in effect the petroleum industry and the public is called upon to furnish this relief. There have been tests made and reported to show that alcohol-gasoline blends have a greater power output than gasoline alone. Other tests have shown quite the opposite, namely, that they have less power output than gasoline. A careful investigation has shown that with proper carburetor and spark adjustment (to give maximum power) the power output of an engine is practically the same whether gasoline or alcohol-gasoline blends are used.

The following table[3] shows the effect of alcohol on knock rating and other factors in engine performance:

| Per cent of absolute alcohol in blend | Increase in octane number | Percentage increase in highest useful compression ratio | Possible percentage increase in efficiency due to increase in highest useful compression ratio | Percentage increase in consumption due to blending of alcohol |
|---|---|---|---|---|
| 5 | 3 | 2 | 1.0 | 2.5 |
| 10 | 7 | 5 | 3.0 | 5.0 |
| 15 | 12 | 9 | 4.5 | 7.5 |
| 20 | 15 | 15 | 6.2 | 10.0 |

A comparison of the last two columns in the table shows clearly that the improvement in thermal efficiency which might be obtained by blending alcohol with gasoline and using engines of higher compressions is not sufficient to compensate for the increase in fuel consumption caused by the lower heating value of alcohol, even though there is an increase in octane number due to the addition of alcohol.

[3]Agricultural Alcohol in American Motor Fuels," George Granger Brown, American Petroleum Institute, Tulsa, May 18, 1933.

The addition of from 5 to 10 per cent alcohol to gasoline increases the vapor pressure, and further increase in the amount of alcohol causes a steady drop in the vapor pressure. The increase in vapor pressure is not accompanied by a proportionate increase in ease of starting; hence, for proper starting and accelerating conditions the blending of alcohol may increase the difficulty due to vapor lock. The presence of alcohol in gasoline in the tank also has a tendency to deteriorate fuel pump diaphragms, possible deterioration of cork floats, and similar difficulties.

One of the real difficulties in the use of alcohol in gasoline blends is caused by its solubility in water. To make alcohol-gasoline blends containing less than 10 per cent alcohol, absolute or water-free alcohol must be used or some intermediate blending agent such as acetone, butyl alcohol, and similar substances must be employed. When such mixtures collect small amounts of water by leakage, they will separate into two layers with the alcohol at the bottom. This will cause carburetor difficulties and starting would be well-nigh impossible in cold weather. Less than 0.1 per cent of water in the blend is required to cause the separation of 10 per cent alcohol at 20 deg F, and 1 per cent water will cause a separation of 50 per cent alcohol. Mere traces of water will cause separation of less than 5 per cent alcohol.

One of the objections made recently to the so-called Hi-Ball gasoline[4] or "alky motor fuel," is the ease with which the alcohol may be separated by mere agitation with water and subsequent concentration corresponding to 100-proof whiskey.

Aside from all of the objections of a technical character already referred to, the economics of the situation appear to be entirely against the proposal. Denatured alcohol (95 per cent) sells in a highly competitive market for approximately 25 cents per gallon. The raw material (molasses) for its manufacture costs approximately 10 to 12½ cents for each gallon of alcohol. The cost of anhydrous alcohol from a 5-cent per gallon molasses would be approximately 30 cents per gallon.

The production of alcohol from corn requires approximately 0.36 bushels per gallon on this basis. The cost of alcohol from corn at 20, 40, and 60 cents per bushel has been calculated by Brown and others to be approximately 30, 40, and 50 cents, respectively with a minimum eliminating certain overhead expenses of 25, 30, and 40 cents per gallon, respectively.

In order to produce the amount of alcohol of approximately 1,580,000,000 gallons required to treat all motor fuel now used with 10 per cent of alcohol, it would be necessary to increase the present capacity for alcohol production more than seven times, calling for a tremendous investment. An exhaustive analysis of this problem by Brown, Egloff, and others shows that the country would suffer a net loss of almost one-half billion dollars annually depending upon the price of corn.

The problem of gasoline-alcohol blends has been treated at some length because of its peculiar interest to those directly connected with agriculture. No doubt it only represents one phase of the complicated social and economic conditions through which the world is passing at present and in reality is not a problem which would be normally encountered by the petroleum industry, since it could otherwise be readily disposed of by the application of technical and scientific principles. If alcohol were shown to be a superior motor fuel, or if there were any advantages in its use either alone or in combination with gasoline, petroleum technologists could employ hydrocarbon gases particularly those obtained from the cracking process to manufacture it. On the other hand, problems which affect the agricultural and petroleum industries can be readily solved to the best interests of both by a scientific study of them and the proper cooperative spirit.

[4]Gustav Egloff, National Petroleum Association, Cleveland. April 20, 1933.

# Agricultural Engineering Digest

A review of current literature on agricultural engineering by R. W. Trullinger, specialist in agricultural engineering, Office of Experiment Stations, U. S. Department of Agriculture. Requests for copies of publications abstracted should be addressed direct to the publisher.

**Harvesting and Drying Rough Rice in California,** R. Bainer (California Sta. Bul 541 (1932), pp 29, figs 14).—The results of studies of the different methods of harvesting and drying rough rice in California and of the relation between them and milling quality are presented.

It was found that weather plays the most important part in the harvesting of the rice crop. A well-planned, adequate drainage system is essential to rice production, especially to the harvesting of the crop. The method of seeding plays an important part in the success of the windrow pick-up system. Rice seeded broadcast, either by the common broadcaster or by airplane, is easier to handle than rice that has been planted by a drill. To facilitate rapid drying the windrow must be supported by erect stubble.

Three different methods are used in the harvesting of California's rice crop, namely, the binder-thresher method, the windrow pick-up in conjunction with the combine, and direct combining. At present approximately 75 per cent of the crop is handled by the binder-thresher method, and 25 per cent is handled by the combine. Practically all of the combined rice is first windrowed and after drying for from 3 to 8 days is threshed by a combine equipped with a pick-up. Direct combining is possible when the moisture content in the standing rice is below 15 per cent or when some means of artificial drying is available. A push header with a 2-ft cutter-bar extension mounted on the front of a tractor is the most satisfactory means for the opening of rice checks when the windrow pick-up method is used. The cost of harvesting by the binder-thresher method varies from $15 to $20 per acre, while the cost of harvesting by the windrow pick-up method varies from $4.75 to $6.75 per acre.

In a study of losses from the windrow pick-up system, it was found that they may be held below 1 per cent if proper machine adjustments are maintained and if good weather prevails throughout the harvest period, while the losses from the binder method vary from 2 to 10 per cent. Only from 10 to 15 acres can be handled per day when threshing windrows consisting of the grain from a 12-ft swath. Three hundred acres of rice is the maximum amount that one combine should be expected to handle.

More agitation in the separating chamber is desirable for the threshing of rice that for wheat or barley because of the usual damp condition of the rice straw. Rice having a high moisture content does not give high yields of head rice since it lacks resilience to withstand the milling process. Rice containing an excess of moisture may be artificially dried. Temperatures in the drier should not exceed 100° F. Paddy rice may be handled safely in bulk or in sacks if the moisture content is below 15 per cent.

Fractures, called sun checks, are caused by high temperatures at the time of drying rather than merely by exposure to the sun. Temperatures of from 120 to 130° are commonly found in parts of shocks and windrows that are exposed to the sun. These high temperatures cause too rapid drying of the rice kernels, which in turn produces sun checks. The percentage of sun checking is considerably higher in these exposed parts. Sun checking in brown rice is a fair, though not a positive, indication as to what milling yields may be expected.

**Irrigation of Orchards by Sprinkling,** F. L. Overley, E. L. Overholser, H. L. Garver, S. C. Vandecaveye, A. Spuler, O. M. Morris, C. P. Harley, E. L. Reeves, and H. C. Diehl (Washington Col. Sta. Bul. 268 (1932), pp 50, figs 16).—The results of an investigation conducted by the station in cooperation with the U.S.D.A. Bureau of Plant Industry, Chelan County, Wash., and the Wenatchee Valley Traffic Association are reported. A description is given of gear-driven, reaction, and stationary head sprinklers and of their methods of operation. The reaction type of sprinkler was found to be the most efficient for orchard irrigation. A discussion is also given of the operating characteristics of sprinklers, including such factors as capacities, trajectory, uniformity of coverage, pressure, pipe friction, and elevation.

It was found that the factors that determine the amount of evaporation between the sprinklers and the ground are wind, relative humidity, and temperatures of irrigation water and of the air. The percentage of water evaporated from sprinklers throwing a fine mist was no greater than from those throwing relatively large droplets of water. Small droplets, however, are more easily carried away by the wind.

The equipment required for sprinkler systems of irrigation is discussed, special attention being given to piping, pump, settling box, and the sprinklers themselves, and directions are given for installation.

It was found that as the pumps for stationary spray plants are designed for pumping comparatively small quantities of liquids against high pressures they are not generally satisfactory for pumping irrigation water. Ordinary stationary spray system pipes are small and offer excessive resistance to the flow of large quantities of irrigation water. By using light, welded steel tubing and movable sprinklers the cost of installation may be as low as $40 per acre when pumping equipment is not required. The cost, depending upon elaborateness, may as high as $350 per acre.

Sprinklers make it possible to apply water more uniformly over areas to be irrigated, regardless of soil type or degree of slope of land. On bare soil, however, when sprinkler water is applied faster than the soil can readily absorb puddling or washing of the soil may result. When properly applied without waste, 30 to 36 acre-inches of water are generally sufficient to keep the main root zone of the soil supplied during the growing season. Since the sprinkler system wets the surface soil uniformly, it provides excellent moisture conditions for germination and initial growth of a new cover crop.

Trees in sprinkler plats during the experimental period made greater terminal growth and tended to produce larger-sized leaves and fruits, notwithstanding the fact that less water was applied, than did trees irrigated by the furrow system. The average amount and intensity of the color of the fruit was lessened and the maturity was slightly delayed by the use of sprinklers as compared with rill-irrigated trees.

The overhead sprinkling has no value in codling moth control but instead interferes with the proper control by spraying methods. Aphis infestation and leafhopper injury were not affected by sprinkling. Overhead sprinkling, however, seemed to aid in the control of red spiders.

There was a reduction in the average load of spray residue on mature fruit harvested from trees irrigated by overhead sprinklers amounting to from 30 to 35 per cent when compared with trees irrigated under the rill system. With ground sprinklers, the reduction was on fruit within 6 ft of the ground and amounted to as much as 50 per cent. The reduction apparently resulted from the weathering or the solvent effect of the water sprinkled on the fruit. There was a greater spray residue load on fruit from the lower levels of trees with overhead sprinklers, possibly because of the run-off and drip that accumulated or the better initial coverage received.

The percentage of powdery mildew markings on Jonathan apples at harvest time from trees irrigated by overhead sprinklers was one-half that on fruits irrigated by ground sprinklers or with furrows.

The effectiveness of sprays under sprinkers was reduced by the washing off of the copper sprays. Pear blight was found to be more active later in the season in orchards with overhead sprinklers than in orchards irrigated by furrows. The ground sprinklers appeared to have fewer disadvantages than did the overhead sprinklers. The former required less pressure and did not wash off so much spray material. Furthermore, they did not favor certain diseases as much as did overhead sprinklers. Ground sprinklers, however, required additional piping and equipment to irrigate an equal area as compared with overhead sprinklers. The sprinklers seemed most likely to be economically successful on light, sandy, hillside soils where the natural head of water was sufficient to avoid the use of booster pumps.

**Cost of Pumping for Drainage in the Upper Mississippi Valley,** J. G. Sutton (U. S. Dept. Agr., Tech. Bul. 327 (1932), pp 100, figs. 16).—This report presents detailed data on the operation and cost of 17 typical drainage pumping plants in Illinois, Iowa, and Missouri, based on a study extending over a period of six years and a comparison of a total of 70 plant years of records.

The districts having no gravity drainage pumped an average yearly run-off of from 13 to 40 in depth over the watershed area. Several districts were affected by backwater from dams to such an extent that the river level was from 6 to 8 ft above the level of the water in the districts at normal low-water stage. It was found that such districts pumped almost double the quantity of water pumped by similar districts not affected by dams.

Three types of power have been used in recent years to operate drainage pumping plants—steam, electric, and oil engine. Steam was the earliest type used, but no new steam plants have been built since 1920. Much of the old steam equipment has been replaced by electric or oil-engine units because it was not dependable and was too expensive in operation.

Under conditions obtaining at the time these studies were concluded, electric and oil-engine power are the most economical type to use. At about 15 per cent plant factor the average total cost of pumping by the oil-engine group of plants was 2.2 c per brake horsepower-hour, and by the electric lants 2.7 c. At slightly higher plant factor the average cost for the steam group was 2.9 c per brake horse-power hour. Below about 12 per cent plant factor the cost of pumping with the electric plants gen-

erally was less than with the oil-engine plants, and above 12 per cent plant factor generally was more.

The average costs per acre-foot pumped were 60 c for the oil-engine group and 77 c for the electric group, at approximately 10-ft average lift and only slightly different plant factors. The cost for the steam plants was only 55 c per acre-foot at a static lift of about 7 ft, but this is much less than could be obtained with similar plants built at prices current during the past decade.

The average annual costs per acre of watershed were $1.13 for the oil-engine group, including the costs of the steam standby units, and $1.40 per acre for the electric plants. Part of this difference was due, however, to the difference in the amounts of run-off pumped, which were 15.07 in by the oil-engine group and 21.75 in by the electric group. For the all-steam group, pumping 24.74 in of run-off, the cost per acre of watershed was only $1.06, reflecting the low cost per acre-foot pumped.

The average annual costs per acre assessed, for the plants studied, were $1.84 for the electric group, $1.48 for the oil-engine group, and $1.96 for the steam group. This cost bears no definite relation to any other unit cost except that it is larger than the cost per acre of watershed. Fixed charges constituted 45 per cent of the total cost of pumping with oil engine and 33 per cent with electric power. This fact emphasizes the greater importance of economy in first cost for oil-engine plants than for electric plants.

Fuel and lubricants have constituted 23 per cent of the cost of pumping with the oil-engine plants, while current has constituted 53 per cent with the electric plants. This comparison emphasized the special importance in the latter type of an advantageous power rate and of efficiency in both design and operation of the whole plant.

The difference in labor costs, which were 19 per cent for oil-engine plants and 7 per cent for electric plants, are largely inherent in the types of equipment. The same is true concerning difference in costs for repairs and supplies, which were 6 per cent and 2 per cent for the respective power types. The miscellaneous and overhead expenses amounted to 7 per cent for the oil-engine plants and 5 per cent for the electric plants.

**The Hager Knife Sled,** H. H. Finnell ([Oklahoma] Panhandle Sta., Panhandle Bul. 43 (1932), pp 6, fig 1). Modifications of the common knife sled used in the cultivation of listed row crops are briefly described and illustrated.

Instead of a straight-edged blade the cutting edge is serrated. Otherwise the blade is of the same form as those ordinarily used. The serrations are obtained by drawing out the edge at intervals of about 4 in on an ordinary straight-edged blade when it is being sharpened. The effects of a serrated edge are mainly to increase the cutting efficiency of the blade. It is enabled to cut weeds so large as to resist a smooth knife and to cut its way through accumulations of trash which might otherwise foul the blade. The serrations also serve to maintain the cutting efficiency of the blade after the edge is much worn.

The second modification consists of a pair of short secondary knives carried on the heel of the sled which are curved up at the end in such a manner as to draw into the furrow a sufficient amount of loose soil to cover small weeds in the drill row, thus enabling the sled to do a complete job of cultivation at one operation. The secondary blades also act to stabilize the implement, reducing side play and increasing considerably the ease of operation.

**Use of Wood Gas as Fuel for Power Motors** [trans. title], G. Kuhne and E. Fischer (Technik. Landw., 13 (1932), No. 4, pp 75, 76, fig 1). This is a brief preliminary contribution from the Technical Academy of Munchen in which experiments were undertaken to reveal lines along which the efficiency of wood gas as an internal-combustion engine fuel may be increased.

It was found that the power output of wood gas in a tractor motor was about 38 per cent less than that of benzol. However, its antiknock properties permit raising the compression ratio resulting in higher thermal efficiency, less combustion residue, and more complete combustion. It is thought that these factors may be utilized to offset the lower fuel quality of the wood gas to a considerable degree.

**Purification of Water Especially for Drinking Purposes by Filtration** [trans. title] W. Hoffman (Fortschr. Landw., 7 (1932), No. 20, pp 511-515, figs 6). In a contribution from the Moorland Experiment Station at Bremen, Germany, the results of studies on the purification of water obtained from heath sand soil are reported. It was found possible to improve this water by aeration and sand filtration, and a further improvement was secured by ultra-filtration.

**Investigations of Warm-Air Furnaces and Heating Systems, Part V,** A. C. Willard, A. P. Kratz, and S. Konzo (Ill. Univ., Engin. Expt. Sta. Bul. 246 (1932), pp 158, figs 73). This is a progress report of investigations which are being conducted in cooperation with the National Warm-Air Heating Association (E.S.R., 61, p 577). It describes a continuation of studies in the research residence at the station and deals with individual features of warm-air heating.

Studies of room air temperature conditions, with warm-air registers located near the ceiling or near the floor, showed that with gravity operation the high side-wall register combination in a second-story room delivers from 15 to 20 per cent more heat through the register than the baseboard combination, for an equal supply of heat to the furnace. However, the additional heat was offset by the increased heat losses from the upper part of the room, and no increase in temperature of the air below the breathing level occurred.

Studies of the effect of wind and sunshine on house operation showed that a moderate outdoor temperature accompanied by a strong wind may produce as great a heating load as a materially lower outdoor temperature and a light wind. Thus the use of the degree-day basis only for estimating heating load or comparing the heating demands of different localities may be seriously in error unless the wind movement is substantially the same for the periods or localities compared. Serious consideration should also be given to sunshine or exposure effects on the heating requirements of rooms subjected to solar radiation.

Studies of the cooling effect from the operation of the combination gravity-fan furnace under summer conditions showed that a furnace fan with a capacity sufficient to produce 3.5 recirculation per hour did not produce air velocities at the center of the room to exceed 9 ft per minute. The increase in cooling effect was not appreciable and does not justify the cost of operating such a fan in the summer.

Studies of the performance of a steel furnace with anthracite and bituminous coal showed that anthracite coal can be burned more efficiently than bituminous coal. Bituminous coal can be fired most effectively in small charges and at short intervals and requires the admission of auxiliary air above the fuel bed immediately after firing. This should be reduced to a minimum at the end of the coking period.

In a comparative study of types of furnaces it was found that the ratio of heating surface to grate area has more influence in determining the relative performance of furnaces than the type of furnace or the material from which it is built.

**Analysis of Rural Line Costs** (Elec. World, 100 (1932), No. 15, pp 507-510). An analysis is presented of the costs of more than 700 miles of rural electric lines built in New York state during the past two years. The total number of extensions was 457, having an average length of 1.54 miles. The number of miles analyzed represents about 35 per cent of the normal rural line construction in the state for one year.

The weighted average cost of the primary and secondary line construction, exclusive of transformers, services, and meters, was found to be $1,430.40 per mile. The corresponding total cost per mile was $1,806. As a result of conditions encountered, lines built to the same general specifications varied widely in cost, particularly when compared on a mileage basis. The average number of customers per mile was 5.1, and the weighted average cost per mile represented an investment of about $280 per customer in excess of the normal investment per customer in the urban centers. The cost of right of way and clearing varied from nothing to $124 per mile. The cost of poles and fixtures aggregated about 55 per cent of the total cost. The average cost of labor and materials for the poles and fixtures was $38 per pole., and the cost of the poles alone represented about 20 per cent of the cost of the entire line.

**Irrigation Experience in 1928 and 1929** [trans. title], S. Verdesca (Bari Staz. Agr. Sper. Pub. 20 (1932), pp [2] + 1-36, pls 6). The results of experiments at the station with surface irrigation, subirrigation, and overhead spray irrigation on different crops during 1928 and 1929 are summarized.

The superiority of overhead irrigation for cereals was established with particular reference to economy of water, water penetration into the soil, and crop increase. On the other hand, subirrigation was superior for root growth, with particular reference to the creation of a reserve of moisture in the subsoil.

**A Simple and Rapid Method for Measuring the Stickiness of Soils,** G. Bouyoucos (Soil Sci., 34 (1932), No. 5, pp 393-400, pl 1). Studies conducted at the Michigan Experiment Station are reported in which a method of measuring the stickiness of soils is described. The method is based on the interpretation of stickiness as an important factor in those dynamic properties of soils relating to tilth and the operating of tillage machinery. The principle of the method consists in pressing a small metal disk against the surface of a thoroughly puddled and kneaded soil, and then pulling this metal disk vertically upward by means of a spring balance upon which the force of pull is directly recorded. The moisture content of the soil is gradually varied until the maximum pull is obtained.

The results obtained with the method showed that the maximum degree of stickiness measured in pounds per square inch varies from 0 in muck and sand to about 10 lbs in some of the clays. It appears that there is a fairly close relationship between the maximum stickiness and clay content in most soils, but in some soils this relationship is very slight. There is also some, though not a close, relationship between the maximum stickiness and upper plastic limit in most soils, but there are some very distinct exceptions.

**Present Methods of Testing Draft Animals and Their Defects,** E. Moskovits, ([Internatl. Rev. Agr.], Mo. Bul. Agr. Sci. and Pract. [Roma], 23 (1932), No. 5, pp 173-178). This is a critical discussion of present methods of testing the draft power of horses, and the defects thereof are pointed out. The opinion is expressed that the tests of draft capacity must pri-

marily furnish data for the selection of breeding stock. To obtain this result the findings of draft tests must be expressed in a manner allowing comparison with other tests made under other conditions. It is thought that available methods supply only relative facts, the classification being affected by means of points, thereby giving no information regarding the quantity of work done by animals being compared.

**The Strength of Concrete Masonry Walls After Standard Fire Exposure,** C. A. Menzel (Jour. Amer. Concrete Inst., 4 (1932), No. 3, pp 113-142, figs 11). This paper presents data on the load-carrying capacity of concrete masonry walls, made with units of widely varying characteristics, both during and after exposure to standard fire test conditions. Comparative data on similar walls not exposed to fire are also included. The investigation comprised tests on more than 200 walls 5.5 ft wide, 6 ft high, and 4, 8, and 12 in thick, and are of significance in connection with the development of fire resistance in farm structures.

It was found that the compressive strength of concrete masonry walls, tested both without exposure to fire and after exposure to fire, was directly proportional to the original compressive strength. The strength of walls exposed to fire was influenced to a more marked degree by the type of aggregate than by the type of mortar, but to an even greater extent by the type of mortar joints and character of mortar bedding. When the cement content of the mortar was reduced below that of a 1:1:6 mixture, a decrease resulted in wall strength which was approximately proportional to the decrease in the cement content of the mortar. The strength of walls plastered on either the exposed face or on both faces was appreciably higher after fire exposure than that of unplastered walls exposed for the same or shorter periods.

No outstanding advantage was discernible in wall strength after fire exposure for one design of unit over another in tests of walls of the same thickness laid up with units of different design, but comparable as to the proportion of core area, the proportion of net area bedded, and strength (gross area). An outstanding feature of the investigation was the substantial load-carrying ability and safety exhibited by the walls before, during, and after severe fire exposure.

**Flow of Water Through Circular, Parabolic, and Triangular Vertical Notch-Weirs,** F. W. Greve (Purdue Univ., Engin. Expt. Sta. Research Ser. 40 (1932), pp 84, figs 15). A large number of studies are recorded the purpose of which was to determine the relation between head and rate of discharge for a given weir notch and to develop a general equation for computing the rate of discharge through different notches of given shape.

In tests of circular weirs it was found that a change occurs in the logarithmic relation between head and discharge when the depth in the plane of the notch equals the radius and again when the depth is equal to the maximum hydraulic radius. It was found that the advantage of the circular notch, together with its diminutive form, the semicircular notch, lies in the ease and accuracy with which it can be formed. A restrictive range in head constitutes its principal disadvantage. This type of weir is not to be recommended for a depth through the notch greater than the radius.

Tests of parabolic weirs showed that the discharge coefficient for beveled notches and negligible approach velocity decreases as the head and size of opening are increased. It is also apparent that the numerical change in the coefficient for any weir is approximately constant between heads of 0.1 and 1.2 ft. The parabolic notch possesses advantages over the rectangular notch for the measurement of relatively small flows. The disadvantage of the parabolic notch lies in the difficulty of cutting it true to form.

Experiments with triangular weirs indicated that the assumption so frequently made that the discharge coefficient is constant for a given notch is erroneous. Apparently the coefficient is dependent upon head and independent of size. It is considered unwise to formulate a general expression for discharge from such weirs from data compiled from different sources unless such an expression incorporates certain factors which correlate the variations in the physical characteristics of the testing plants.

Four appendixes are included, one consisting of an abstract of literature on the subject of weirs and water measurement and the other three giving tables of data for the three types of weirs tested.

**Aggregate Analysis as an Aid in the Study of Soil Structure Relationships,** L. D. Baver and H. F. Rhoades (Jour. Amer. Soc. Agron., 24 (1932), No. 11, pp 920-930, figs 6). Studies conducted at the Missouri Experiment Station are reported which involved experiments with the elutriator as a means of determining structure relationships with soils.

The principle of the elutriator is based upon the separation of particles by a moving stream of water, this being accomplished by regulating the velocity so that it will just balance the rate of fall of the particle or aggregate as calculated by Stoke's law. The elutriator used consisted of three elutriation tubes of different diameters, arranged with the tube of smallest diameter connected directly with the water supply, and in which the soil is placed for analysis. The third elutriation tube is the largest in diameter and possesses an outlet and a piezometer tube to indicate the velocity of the water.

The results suggest that the state of aggregation designates the extent to which a soil breaks up into aggregates, and that the stability of structure refers to the stability of the structural aggregates.

**Solution of Special Problems in Pipe Flow by Graphical Analysis,** G. K. Palsgrove (Rensselaer Polytech. Inst., Engin. and Sci. Ser. No. 37 (1932), pp 29, figs 10). An intricate mathematical and graphical analysis covering five special cases of flow in pipes is presented.

**The Cultivation Experiments of 1929-1931,** C. Davies (Jour. Southeast Agr. Col., Wye, Kent, No. 30 (1932), pp 97-101, figs 4). Studies conducted at the South-Eastern Agricultural College of the University of London are reported in which seed beds for cereals were prepared by rototiller, pulverator, digger plow, and general-purpose plow.

The yield data show that the finer the tilth the greater the tillering, up to a certain point, after which the death rate was higher. In effect, the finest tilths produced the lowest yields. The pulverator produced results similar to those of the rototiller,, although the yields were not quite as low. The use of the general-purpose plow throughout resulted in the production of larger crops than the use of the digger plow.

Studies of consolidation showed that the looseness of the tilths produced by the rototiller and the pulverator, which were noticeable immediately after preparing the soil, disappeared after drilling and harrowing. The coarse tilth prepared by the general-purpose plow seemed to suit cereals better than those produced by the other plows. The tilths produced by digging with a spade and with a fork did not result in any differences in yield, and the conclusion is reached that the work done by digging with a fork, although much finer than that produced by a spade, differs from that produced by the milling rotary cultivators.

**A Test of a New Type of Force-Feed Cereal Drill,** C. Davies (Jour. Southeast Agr. Col., Wye, Kent, No. 30 (1932), pp 102-109, fig 1). Results of laboratory and field tests of a special type of force-feed drill are reported.

The machine had 14 coulters, 6 in apart, and was mounted on two 48-in wheels, one of which drove the feed mechanism. Seven openings were provided in the back of the hopper, each of which was variable in size, being controlled by a sliding shutter. The feed mechanism consisted of a vertical rotating iron cone, which also had an up and down motion. There were seven feeds, one being placed opposite each shutter, and each feed fed grain to two coulters.

The laboratory tests showed that the intercoulter performance could be improved by adjustment of the mechanism, and that further improvements could be obtained with additional devices. The quantities of grain ejected decreased with increases in drill speed. Uneven fields adversely affected the even delivery. No superiority of performances along rows was observed over other force-feed drills.

**The Principles of Woodworking: A Survey of Present Knowledge on This Subject,** W. W. Barkas, E. D. van Rest, and W. E. Wilson ([Gt. Brit.] Dept. Sci. and Indus. Research, Forest Prod. Research Bul. 13 (1931), pp VI + 35, figs 29). A survey is presented of the present knowledge of the subject. It deals with the general principles of cutting, rotating cutters, and saws, and suggests a program of experimental work. It contains a bibliography and appendixes on cutting angles, grinding angles, and sharpness angles on the rotary planer; ripple marks, hook and clearance in the ripsaw tooth, grinding cutters for wood-molding machines; and change of effective cutting angle with inclination of knife to the direction of cut.

**Studies of Methods of Grain Drying, II** [trans. title], A. Akerman and J. E. Lindberg (K. Landtbr. Akad. Handl. och Tidskr., 71 (1932), No. 3, pp 233-256, figs 2; Eng. abs. pp 255, 256). Studies conducted by the Royal Agricultural Academy of Sweden in cooperation with the Swedish Association of Agricultural Engineers are briefly reported in which a comparison was made of the drying of wheat brought together in Dutch shocks and wheat brought together in large perches in which from 10 to 16 bundles are placed around a stake and 8 others are hung upon the stake. It was found that the latter method offers an effective protection against unfavorable harvesting conditions and is preferable to the Dutch shock method. It is also cheaper in labor cost. The greatest value of the perching method consists in its protection against germination. The flour from wheat cured in perches had a superior baking quality to flour from wheat cured in Dutch shocks.

**Rapid Filter Hydraulics Disclosed by Experiments** (Engin. News-Rec., 109 (1932), No. 22, pp 647-650, figs 5). Experimental data are reported from which the loss of head resulting from the passage of clean water through a bed of graded sand is evaluated in terms of the physical factors, including depth, rate, size, porosity, and temperature.

(Continued on page 230)

# AGRICULTURAL ENGINEERING

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## A Depression-Proof Electrical Load—the Farm

THE amazing vitality of the agricultural engineering profession in resisting the withering effects of general adversity has been mentioned in these columns. A strong factor in that vitality is the Rural Electric Division of the American Society of Agricultural Engineers, and the activity which it represents and fosters. From the comprehensive paper by Mr. George W. Kable appearing in this issue, and which is in effect a summary of an annual report on farm electrification progress, a few facts should be picked out for added emphasis.

During the year 1932, when every important business index showed shrinkage, including the national consumption of electrical energy, and despite the distressed condition of agriculture, the number of farms connected to electric power sources increased by more than one per cent.

Over a period of several years leading into and through the depression, and including broadly all sections of the country, except where irrigation pumping is the dominating influence in energy consumption, the per-farm consumption of electric power has increased consistently and significantly.

At least one company has found that energy consumption and gross revenue per mile of line increased as the number of consumers per mile decreased, challenging the assumption that population density is the limiting factor in rural electrification.

Considering the statement by the director of the Committee on the Relation of Electricity to Agriculture to the effect that creation or adaptation of the farm load for electric power has been almost entirely the work of agricultural engineers, they might point with pride to the record. Instead, they point out that progress thus far has been little more than to substitute electricity for the pump-handle, broom-handle, and kerosene-can. The distinctively agricultural uses of electricity remain to be developed; most of them, indeed, to be discovered. The use, first of ordinary electric light and then of ultraviolet radiation, in poultry husbandry is but a hinted prophecy of the biological influences which electricity will wield in both the animal and plant kingdoms.

Some early gropings of the prophetic hand were shown by other speakers in the Rural Electric Division sessions at the Purdue meeting of the Society. For example, it has been found that rather small amounts of artificial light, properly timed and of suitable spectral content, produce striking changes in the growing and flowering habits of certain plants.

However far-reaching these biological and other strictly agricultural uses of electricity may prove to be, whatever load they provide is in addition to the possible motor load for ordinary power purposes. As Mr. Kable remarks, the present power requirement of farming equals that of complete railroad electrification, or about the total generating capacity now existing. Adaptation of that load to electric power is almost exclusively the job of the agricultural engineer.

So, too, with electric heating in agriculture. This, the simplest application of electric energy from the strictly electrical standpoint, depends utterly on the research and the ingenuity of the agricultural engineer in making the applied energy earn more than it costs, whether it be in adjusting climate by soil warming or by keeping brooder floors at the optimum temperature for the feet of baby chicks. In the case of soil-warming, particularly, the electrical industry may well bear in mind that once the earnings are brought up, or the cost of energy down, to a favorable economic balance there is almost unlimited load available.

With their brief but brilliant record behind them, and a vision of the job before them, the agricultural engineers in farm electrification have a sound basis for the vitality they contribute to the profession.

## Speeding the Man to the Job

ALWAYS a vital part of the service of the American Society of Agricultural Engineers to its members, and equally to related industries and institutions, its employment services has lately taken on added importance and attention. Still more recently, it is gratifying to report, it has shown unusual activity. While the list of A.S.A.E. members available for employment expanded during the dull years, it remained small relative to the conditions in most occupations. Now it is shrinking so rapidly as to suggest that employers should be a bit forehanded in seeking men qualified in special phases of agricultural engineering.

Unforeseen by any of us, this and other parts of our Society activity through the years past has enabled us to aid substantially in rapid mobilization for the federal emergency conservation program. Engineers, mainly qualified in so-called reclamation, were needed and needed immediately. Public officials, both state and federal, called on Society headquarters for nominations of suitable men. One federal bureau specified an even dozen of men in a single inquiry. Thanks to the data in the "Men Available" files, supplemented by a broad acquaintance with the membership, it was possible to make a high percentage of suitable suggestions.

This, however, is only the more obvious part of the Society's service to the nation and to its members. Beside the presumption set up by mere qualification for membership in the Society, years of association with other members at meetings and otherwise have given to each such candidate a list of "references" who can say with some authority how well adapted, personally and professionally, he is likely to prove in a specified responsibility. These, in turn, are men whom the appointing official or executive is likely to consult.

* * * *

The privilege of using the Society's employment service for the purpose of securing employment is, of course, limited to A.S.A.E. members, for obvious reasons. However, employers with positions to fill, and for which members of the Society would qualify, may use this service for that purpose, and are encouraged to do so.

# A.S.A.E. and Related Activities

## A.S.A.E. Appointments for 1933-34

PRESIDENT Arthur Huntington of the American Society of Agricultural Engineers has recently announced a number of appointments, which the president of the Society is required to make each year at the beginning of his administration. These appointments are for the Society year 1933-34. The Society year begins and closes with the annual meeting, at present held sometime in June.

Each year the new president appoints a vice-chairman of each division, who automatically assumes the chairmanship of the division the following year. President Huntington has appointed A. W. Lavers, vice-chairman of the Power and Machinery Division, of which R. B. Gray is chairman this year. It was necessary to appoint both the chairman and vice-chairman of the Rural Electric Division, and these offices will be held by Richard Boonstra and B. D. Moses, respectively. W. G. Ward is the new vice-chairman of the Structures Division, C. F. Miller being the chairman. The newly appointed vice-chairman of the Land Reclamation Division is L. A. Jones, the chairman being W. W. Weir. J. C. Wooley is the new vice-chairman of the College Division, the chairman being G. W. McCuen.

Under the heading of A.S.A.E. representatives on other organizations, President Huntington has re-appointed J. B. Davidson as the Society's representative on the Committee on the Relation of Electricity to Agriculture, which position Dr. Davidson has held since the Committee was organized about ten years ago. J. R. Haswell has been appointed as the Society representative on the Advisory Council to the Federal Board of Maps and Surveys, U. S. Department of the Interior. W. G. Kaiser has been appointed the Society's representative on the Agricultural Committee of the National Fire Waste Council, U. S. Department of Commerce, and S. H. McCrory will continue to represent the Society on Committee C-6 (Drain Tile Specifications) of the American Society for Testing Materials. R. W. Trullinger, E. W. Lehmann, and H. B. Walker have been re-appointed as the Society's representatives on the Joint Committee on Rural Sanitation, sponsored by the Conference of State Sanitary Engineers and the Public Health Engineering Section of the American Public Health Association.

L. J. Fletcher and R. W. Trullinger will continue to represent the Society, as representative and alternate, respectively, on American Engineering Council. The Nominating Committee of the Society, elected earlier this year by voting members, includes E. W. Lehmann (chairman), W. G. Kaiser, and S. P. Lyle.

C. E. Seitz, junior past-president of the Society, automatically becomes chairman of the Finance Committee. The members (at large) of the Meetings Committee consist of J. L. Fletcher (chairman), W. G. Kaiser, H. B. Walker, C. E. Seitz, and Henry Giese. The members representing the divisions are R. B. Gray, Richard Boonstra, C. F. Miller, W. W. Weir, and G. W. McCuen.

The entire personnel of the Membership Committee has been reappointed and consists of C. G. Krieger (chairman), F. W. Hawthorne, A. W. Lavers, L. F. Livingston, S. P. Lyle, C. F. Miller, G. A. Rietz, and W. W. McLaughlin. The Standards Committee consists of W. H. Worthington (chairman), F. N. G. Kranick, O. B. Zimmerman, J. L. Strahan, and E. A. White.

The Committee on Extension, as appointed for the coming year, consists of two groups: the private industry group and the public service group. E. G. Welch is general chairman of the Committee. K. J. T. Ekblaw is chairman of the private industry group, other members of which include L. F. Livingston, H. H. Sunderlin, C. P. Tobin, F. A. Lyman, F. A. Wirt, C. F. Miller, R. E. Hayman, and G. A. Rietz. R. D. Barden is chairman of the public service group, the other members of which are J. T. Copeland, E. G. Johnson, W. G. Ward, and T. E. Hienton.

The personnel of the Jury of Awards of Honor, which is not appointive, but which consists of the seven immediate active past-presidents of the Society, with the junior past-president serving as chairman, consists of C. E. Seitz (chairman), L. J. Fletcher, R. W. Trullinger, W. G. Kaiser, Wm. Boss, O. B. Zimmerman, and O. W. Sjogren.

The various division chairmen are at present organizing their respective committee groups, announcement of the appointment of which will be made later. These committee groups, however, usually have very little turnover in personnel from year to year,

## A.S.A.E. Student Group Organizes

MEMBERSHIP in the student branches of the American Society of Agricultural Engineers was well represented at the 27th annual meeting of the Society held at Purdue University in June. Due principally to the large number present from the Oregon Student Branch, the registration of students was larger than at any previous meeting.

At their special session the students indicated a particular interest in having sufficient time set aside at the annual meeting each year for a business and technical session. In response to their request, it is planned for the next annual meeting to have the student session parallel that of the College Division, which heretofore has been held on the first day of the meeting. Both the planning and the presenting of the program will be in the hands of the students themselves.

It is planned that this student meeting each year shall be one of the features of the A.S.A.E. annual meeting, and it will perhaps be given some such name as "Agricultural Engineering Students' Conference." During their session at the Purdue meeting, the students elected national officers for such an organization, and these officers will direct the work of arranging for the program to be presented at next year's meeting. The officers elected were as follows: President, Henry Collin, Oregon State College; Vice-President, Stanley E. Hill, Ohio State University, and Secretary-Treasurer, Shafer Meeks, Pennsylvania State College—shown in the picture at the left in the order named, left to right.

the principal changes being due to members who engage in other lines of activity unrelated to the particular work of the committee, and also the addition of new members who from time to time engage in work along the lines on which the committee is working.

## C.R.E.A. Annual Report Reviews Decade in Farm Electricity

THE tenth annual report to the Committee on the Relation of Electricity to Agriculture by its director, Dr. E. A. White, is more than a review of one year in which, by force of adverse conditions in general, activity was at low ebb. It is a perspective view of the decade in rural electrification, and a studied look into the uncertain future for the probable developments and needed activity in farm electricity. The 21 mimeographed pages of the report proper are supplemented by a report of the Rural Electric Service Committee of the National Electric Light Association, "Progress in Rural and Farm Electrification for the 10-year period 1921-1931."

Contrary to all indications and expectations, the number of farms served by central station power increased during 1932 by almost one per cent. Total power consumption, however, was nearly 20 per cent less than in 1931. Behind those two facts lies justification for the work of the C.R.E.A., and for its continuance. A decade ago the only extensive use of electricity in farming was for irrigation pumping, and even yet it continues the dominating part of the farm load.

But while the irrigation states during 1932 showed a slight reduction in the number of farms served, and a sharp decrease in consumption per farm, the non-irrigation states showed significant increases in both farms served and consumption per farm. These increases in nonirrigation areas are due largely to applications and projects fostered by the C.R.E.A. While their total energy consumption is but a fraction of the irrigation load, they have the merit of being relatively independent of general economic condition, of rainfall, and of competition from other forms of power.

Couple with other adverse influences, the dissolution of the National Electric Light Association and its succession by the Edison Electric Institute, not yet fully developed, has been a severe, though perhaps temporary, handicap to the C.R.E.A. There has been shrinkage in the number of state committees on the relation of electricity from a maximum of 25 to '13, and of these latter some show little activity. This is not so much a decrease in activity as a transfer to educational institutions, experiment stations, and other agencies. For financial reasons the work of the National Rural Electric Project has been suspended. While this work was of a high order, the director is of the opinion that it might well be distributed among state projects, in line with a general policy of decentralization.

The present movement of population from city to country is probably temporary and limited, in the director's opinion, but is significant in that urban dwellers take with them their demand for electric service. The desire of farmers generally for electricity continues unabated, despite economic abeyance, and Dr. White notes further a change from the ideal of selling the farm and moving to town to one of perfecting the farm as a place of permanent residence.

## New Publications of A.S.A.E. Members

**"Durability of Posts, and Results of Preservative Treatment,"** by Deane G. Carter*, Harold T. Barr*, and John B. Woods*. Bulletin No. 287, University of Arkansas Agricultural Experiment Station, Fayetteville.

**"The Financial Rehabilitation of Irrigation and Drainage Districts,"** by G. E. P. Smith*. Bulletin No. 144, Arizona Agricultural Experiment Station, Tucson.

**"The State College of Washington Experimental Fruit Washer,"** by Harry L. Garver*, Homer J. Dana, and Fred L. Overley. Bulletin No. 285, Washington Agricultural Experiment Station, Pullman.

**"The Classification and Evaluation of the Soils of Western San Diego County,"** by R. Earl Storie*. Bulletin No. 552, California Agricultural Experiment Station, Berkeley.

**"Power, Labor and Machine Costs in Crop Production"** (Linn County, Missouri, 1930), by Dwight D. Smith* and Mack M. Jones*. Research Bulletin No. 197, Missouri Agricultural Experiment Station, Columbia.

**"Laboratory and Field Tests of Concrete Exposed to the Action of Sulphate Waters,"** by Dalton G. Miller* and Philip W. Manson*. Technical Bulletin No. 358, U. S. Department of Agriculture, Washington.

The asterisk (*) indicates that the authors are members of American Society of Agricultural Engineers.

## Alloy Steel Compositions and Treatment

OF PARTICULAR interest to engineers, metallurgists, purchasing agents, and executives of the agricultural machinery industry is an 8-in circular chart which shows at a glance the nickel alloy steel composition and treatment required to develop yield points up to 175,000 pounds per square inch, in section sizes varying from 1 to 12 inches. The figures used on this chart are based on numerous tests, and may be used as a general guide to the selection of steels for bars, shafting, and forgings of single shape. The chart contains reasonably complete data, and probably represents the first effort to assemble data of this kind in convenient form. The chart was prepared by the International Nickel Company, 67 Wall St., New York, N. Y., and copies of it will be sent on request.

## Personals of ASAE Members

**Stanley F. Morse,** consulting agricultural engineer, Sumter, S. C., is directing a 10-year agricultural development program, which he formulated, for Sumter County. An important feature of the program is that it relies on the farmers to work out their own practical "farm relief." The purpose of this planned development is to stabilize the agriculture of the county on a permanently profitable basis. Production of quality farm products to meet market requirements and reduction of production costs are main objectives.

## New ASAE Members

**Ralph W. Sohl,** field engineer, development department, Goodyear Tire & Rubber Company, Akron, Ohio.

**Victor L. Stedronsky,** junior mechanical engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. (Mail) Box 428, Leland, Miss.

## Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the July issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

**W. J. Agnew,** farmer, Walker, Iowa.

**Forrest L. Bocock,** farmer, Dublin, Virginia.

**Eldon M. Collins,** erosion foreman, U. S. Emergency Work Camp P-53, Albia, Iowa.

**George K. Harnsbenger,** farmer, Port Republic, Virginia.

# Agriculture must not drift "back to the hoe"

Controlled production in agriculture will not benefit the farmer if it tends to "make work" by primitive methods. Control must not only regulate production—it must make profitable whatever production is desired.

Agriculture must not drift back to the hoe, to "work making" methods. The New Deal implies a prevention of drudgery and back-breaking toil just as surely as it does a prevention of over-production. Farm labor must be profitable in method as well as amount, if agriculture is to regain its place as a vocation.

Labor saving methods must prevail to make farm life profitable. The agricultural engineer probably will be the proponent of improved methods. The elimination of stumps and boulders, of crooked ditches, of clogged streams, must keep on to make the acres that are worked yield a fair return in profit and happiness. Explosives will continue to do their part in making land efficiently productive. Without efficiency, there can be no real profit. Just as the use of modern farm machinery must expand, so the use of scientific soil preparation must develop land that is workable without the curse of farm drudgery.

Atlas Farmex Explosives will play a more important part than ever in the *open field movement* that is so necessary to profitable production even at higher farm prices. Atlas publications and service are available for agricultural engineers in these many projects.

ATLAS EXPLOSIVES

**ATLAS FARMEX EXPLOSIVES**

***Agricultural Section***

**ATLAS POWDER COMPANY - - - WILMINGTON, DELAWARE**

# Agricultural Engineering Digest

(Continued from page 225)

**Cultivation of Ratoons Under Unirrigated Conditions on Kauai,** W. P. Alexander (Assoc. Hawaii. Sugar Technol. Rpts., 11 (1932), pp 3-30, figs 34). This is a technical discussion of standard practices in the cultivation of ratoon cane on the unirrigated lands in Kauai. The machinery and equipment used are profusely illustrated, special attention being drawn to deep tillage and pulverizing devices.

**Cultivation on Unirrigated Plantations on the Island of Hawaii,** R. Bryan (Assoc. Hawaii. Sugar Technol. Rpts., 11 (1932), pp 31-35, figs 6). A brief description of cultivation practice on unirrigated plantations on the island of Hawaii is presented, and the cultivating machinery used is illustrated. It is pointed out that the machinery and methods used are adapted primarily to the interests of better weed control.

**Farm Lighting Systems,** C. A. Logan (Kans. Engin. Expt. Sta. Bul. 30 (1932), pp 58, figs 22). The purpose of this bulletin is to give information on the better systems of lighting, to show their probable cost of installation and operation, and to give advice as to their selection, care, and use.

An investigation of the lighting of Kansas farm homes showed that 20,720 out of 166,042 were lighted by electricity. Transmission lines served 10,305 farms, and individual electric plants were found on 10,415 farms. The 32-v, 750 to 800-w plants are the most common sizes of gas-engine electric plants. The battery depreciation was found to be one of the largest single items of expense, and the semiautomatic battery plants were the most economical in the use of fuel. Under the best conditions it was found that the operation of a refrigerator in connection with an individual electric plant is expensive. Data are also given on acetylene, kerosene, and gasoline lighting on Kansas farms.

**Studies in Soil Cultivation.—V, Rotary Cultivation,** B. A. Keen et al (Jour. Agr. Sci. [England], 20 (1930), No. 3, pp 364-389, figs 4). The results of studies conducted at the Rothamsted Experimental Station are reported in which comparisons were made of rotary and ordinary cultivation over a series of years under field conditions.

The rotary machine used is a type commonly used for cultivation in orchards, market gardens, and commercial glasshouses, and consists essentially of a 5-hp engine mounted on and geared to two drivewheels, with a transverse horizontal shaft at the back, also driven by the engine. This milling shaft carries 12 radial tines, six on each side on the central line of the machine and disposed symmetrically about the shaft. The rotation speed of the milling shaft is about 150 rpm.

The outstanding feature of the four years' experiments on rotary cultivation for preparing a seedbed for spring-sown crops is the contrast between the beginning and the end of the growth period. Practically without exception, quicker and better germination and more rapid early growth followed this method of cultivation, also without exception this initial advantage was either lost or replaced by a reduced yield at harvest. The barley crop gave equally good yields under various soil cultivation treatments. The swede crop did not do so well under rotary cultivation, in spite of better early growth.

It was found that meteorological factors exercise a predominating influence on the physical condition of the soil, and that the influence of the implement is secondary. The rotary cultivator was most effective on tough and sticky soils in that in a wet and open winter it produced a smaller proportion of large lumps. It did not produce an appreciably finer tilth than the usual implements, as indicated by measurements of soil pulverization, but it left the soil in a much looser condition, thus encouraging the earlier germination of seeds. The looser tilth becomes more compact with time, resulting in the disappearance of the initial advantage of rotary cultivation. A further comminution of the soil was produced when a ridging body was attached behind the rotary cultivator.

**The Durability of Prepared Roll Roofings,** H. Giese, H. J. Barre, and J. B. Davidson (Iowa Engin. Expt. Sta. Bul. 109 (1932), pp 59, figs 46). Studies conducted in cooperation with the Iowa Agricultural Experiment Station are reported, the purpose of which was to determine quality factors and three-ply prepared roofings as they were sold on the market during 1913.

One square of each of 35 brands of prepared roll roofing made by 19 manufacturers was included in the experiment. The tests were divided into two groups, the first of which was to determine the durability of brands of prepared roofing by subjecting them to actual weather conditions, and the second involving tests for such properties or qualities as were considered to influence durability. The results were subjected to correlation analysis.

The results of the weathering tests showed that the average durability of the samples laid on the south side of the roof was 10 years in contrast to over 13.5 years for the same samples on the north side. Their ranges in durability were from 5 to 14 and 5 to 18 years on the south and north sides, respectively. The weathering tests revealed that the sun is the most destructive weathering agency, and that wind becomes very destructive once the roof is loosened sufficiently to permit flapping. The smaller and flat particles of the mineral surfacing were retained much better than the larger and round particles, the latter soon being lost if applied in too large a quantity. The application of an asphalt roof paint added considerable to the useful life of the roofing.

It was found further that the durability of prepared roll roofing increases with the tensile strength of the felt, decreases with the loss of heat due to volatilization of the original material, and increases with the amount of mineral surfacing on the roofing. The close relationship of mineral surfacing to durability was evidenced further by the fact that both the weight and per cent of ash of original material showed a significant correlation with durability.

**Tractor Engine Tests Using Gasanol, Gastaria, Pure Kerosene, and Mixtures of Pure Kerosene and Crude Oils as Fuels,** A. L. Teodoro and J. Banzon (Philippine Agr., 21 (1932), No. 6, pp 370-413, figs 8). Studies conducted at the University of the Philippines to determine the possibilities of using mixtures of alcohol and gasoline and of kerosene and Diesel engine fuel from the standpoints of economy, crankcase oil dilution, steadiness of engine operation, carbon deposition, and wear in bearings and other moving parts are reported.

The engine used was one of standard make rated at 40 hp. The fuels used included gasanol, which consists of a mixture of rectified alcohol 50 per cent, gasoline from 40 to 45 per cent, and commercial ether from 5 to 10 per cent; gastaria, consisting of a mixture of rectified alcohol 60 per cent and gasoline 40 per cent; three kinds of pure kerosene; and two groups of kerosene-Diesel fuel mixtures. The compression ratio of the engine was approximately 4.42:1.

The results of tests using pure kerosene and mixtures of kerosene and crude oil justified the presence of a water injection attachment to the carburetor. The amount of injection water required was found to be an indication of the antiknock qualities of the fuels. However, when injection water was added in excess quantities the resulting effects were unsteady operation, poor economy, and loss of flexibility.

The highest maximum power was developed in the hydrocarbon groups, and the tendencies to detonate, deposit carbon, and produce dilution were at a minimum. The use of mixtures of kerosene and crude oil not only resulted in increased fuel consumption but caused a greater tendency to carbon deposition, increased wear, decreased power, and crank case oil dilution. These tendencies increased as the percentage of Diesel fuel increased.

The most satisfactory operation was obtained by the use of alcohol-gasoline blends. The operation was characterized by steadiness, silence, and the absence of fuel knocks, together with the greatest maximum power and high thermal efficiency. However, there were indications of corrosion of the exhaust valve stems, which was unfavorable.

Preheating the alcohol fuels proved to be an advantage at low loads because of the resulting better flexibility and lower fuel consumption. However, at high loads extra heat caused not only a decrease in volumetric efficiency with a corresponding loss of power but also unsteadiness in engine operation.

With small variations, an increase in crank case oil dilution indicated a definite decrease in specific gravity and in viscosity of the lubricating oil. The aging of the engine expressed in number of hours of operation from the breaking in period and the piston ring wear showed that it was possible to obtain wide variations in fuel consumption per brake horsepower hour at equal loads from the same fuel. It was also deduced that the greater the percentage of crude oil in the kerosene-crude oil mixtures the greater was the ring wear calculated to length of engine operation, and the higher the dilution and carbon deposit.

With the compression ratio used the alcohol-gasoline combinations gave a slightly higher brake efficiency than the hydrocarbon fuels.

**Laboratory Experiments on Gum-Bearing Gasolines,** S. P. Marley and W. A. Gruse (Indus. and Engin. Chem., 24 (1932), No. 11, pp 1298-1302, figs 4). In a contribution from the Mellon Institute of Industrial Research of the University of Pittsburgh, data are presented from preliminary experiments in connection with a study of the significance of gum content of gasoline as related to gum deposits. While the results were obtained with experimental equipment under laboratory conditions, they emphasize what appears to the authors to be a new importance for one of the principles of engine design.

It was found that a moderate gum content can be tolerated in an engine if the temperature of the mixture in the manifold is kept low, but, as soon as much heat is applied, a fuel containing an appreciable amount of gum will begin to deposit this gum, and such deposits are heavier from a rich mixture than from a lean one. The carbon deposits in the combustion chamber are somewhat, but not much greater with gum-bearing fuels at low intake temperatures, but the well-known tendency to lower carbon deposits with higher head temperatures could readily be invoked to remedy this difficulty.

The results suggest that by lowering intake manifold temperatures volatile gasoline of moderate gum content might perhaps be used without serious trouble from gum deposits. Such a possibility should be considered in its relation to the application of high antiknock cracked gasolines.

# A SOUND ENGINEERING PRINCIPLE

In advising farmers to turn their rich bottom lands into profitable fields so that the long-time, overworked, high ground can rest, or be used for pastures, engineers are doing a practical and far-reaching service.

For making lowlands with their deep deposits of loam available for cultivation, and also for ditching to prevent flooding, Du Pont Ditching Dynamite has advantages that engineers quickly recognize and appreciate.

It explodes evenly and powerfully by propagation. Make a row of holes where a new ditch is to be blasted, or where an old one is to be cleaned or deepened, or where a crooked water channel is to be straightened. Place the required amount of Du Pont Ditching Dynamite in each hole. Then explode the end charges containing a fuse and cap. An immediate explosion of all the others follows—and there's *YOUR* ditch!

The explosion practically completes the job. Blasted-out material is spread evenly on both sides of the new ditch, and no spoil banks are left to be cleared away, or to prevent run-off of surface water.

Du Pont Ditching Dynamite is a *special* explosive for blasting through marshes and other *wet* ground. It makes ditching an easy, quick and effective means to obtain necessary drainage. Instead of merely recommending dynamite for ditching, *always* specify Du Pont Ditching Dynamite.

If you have an emergency ditching problem of any kind, let us have the details and our Agricultural Extension Section will be glad to assist you. Don't hesitate to ask for this service.

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# EMPLOYMENT BULLETIN

**An employment service is conducted by the American Society of Agricultural Engineers for the special benefit of its members. Only Society members in good standing are privileged to insert notices in the "Men Available" section of this bulletin, and to apply for positions advertised in the "Positions Open" section. Non-members as well as members, seeking men to fill positions, for which members of the Society would be logical candidates, are privileged to insert notices in the "Positions Open" section and to be referred to persons listed in the "Men Available" section. Notices in both the "Men Available" and "Positions Open" sections will be inserted for one month only and will thereafter be discontinued, unless additional insertions are requested. Copy for notices must be received at the headquarters of the Society not later than the 20th of the month preceding date of issue. The form of notice should be such that the initial words indicate the classification. There is no charge for this service.**

## Men Available

AGRICULTURAL ENGINEER with bachelor's degree in agricultural engineering from University of Nebraska, desires employment in work where his qualifications and experience will be of value. Has had more than ten years' experience on a large farm in the Middle West, several years' experience as a power machinery service man both in North and South America, and for the past five years has been engaged in experimental and designing work on farm machinery in South America. His experience includes developing rice combines, plows, and corn pickers. Speaks Spanish fluently. Good references. Sober, and single. Will go anywhere. MA-231

ELECTRICAL ENGINEER with B.S., M.S. E.E. degrees in electrical engineering from University of Delaware (1925, 1929, and 1933), desires employment (1) in rural electrification research with a college, (2) in development and engineering work with a manufacturer developing and building equipment for the rural trade, or (3) commercial work with the rural service department of a power company. Experience: Worked and lived on a farm; 1½ years in engineering test work for General Electric Co.; 3 years teaching junior and senior electrical engineering subjects at the University of Delaware. Employed since 1929 as electrical engineer doing research and development work for the National Rural Electric Project. Will go anywhere. Available immediately. MA-233.

FARM MANAGER with B.S. degree in agronomy from Montana State College, desires employment preferably in ranch management, either in operation of ranch properties or handling tenants. Prefers location in Southwest, but will go anywhere. Farm reared. Five years assistant superintendent of farms for large mining company. Seven years agronomist and field manager of Campbell Farming Corporation. Five years manager and part owner of Antler Land Company (Montana). MA-234

AGRICULTURAL ENGINEER with B.S. degree in electrical engineering from State College of Washington (1927) desires employment with an electric power company in rural electrification work, or with a distributor or dealer selling electrical equipment in rural territory. Reared on farm. Took Westinghouse student training course in rural electrification, and since 1928 has been in the service of that company as rural electrification engineer. Will go anywhere. MA-236

AGRICULTURAL ENGINEER, with bachelor of science degree from University of Georgia (1927), and master's degree in agricultural engineering from University of Missouri (1932), desires employment where his training and experience will meet requirements. Reared on Georgia farm. Two years following graduation in 1927 was employed as student trainee, serviceman, and salesman for farm equipment manufacturer. Extension agricultural engineer of Georgia State College of Agriculture for two years, 1929 to 1931, with considerable experience in soil erosion control. On leave of absence (1931-32) working for master's degree. During past year employed by Georgia Agricultural Extension Service in special county agent work. Age 30. Will go anywhere. MA-242

AGRICULTURAL ENGINEER, with bachelor of science degree from Ohio State University (1920), prefers employment in work requiring his particular training and experience. Three years' operation of retail dairy farm; three years in the Steinmetz laboratory (general engineering) of General Electric Company largely testing and checking materials and machinery, and latterly as agricultural engineer for the company; and five years as assistant director of the C.R.E.A., whereby he compiled a number of important publications on rural electrification. Age 35. Married. Will go anywhere. MA-243.

## Positions Open

GRADUATE ASSISTANCESHIPS available at the department of agricultural engineering, A. and M. College of Texas. They will pay $360.00 for nine months and are open to men taking graduate work only. The men appointed to these assistanceships will be expected to spend their itme working for the department and the other half to be put on graduate work. A state law in Texas requires that the tuition charge to out-of-state students shall be the same as that charged by the state from which an out-of-state student comes. For further information write D. Scoates, Agricultural Engineering Department, A. & M. College of Texas, College Station.